VOLUME 38
NUMBER 6

JUNE, 1951

plating

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See Contents Page 551

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CLEPO POWDERED ACIDS GIVE EQUIVALENT RESULTS TO CARBOY ACID AND ARE EASIER AND SAFER TO USE.

1. CLEPO 193-B Compound—Inhibited acid powder for pickling scale and rust from Steel.
2. CLEPO 191-M Compound—Acid powder for use in plating cycles to replace Sulfuric Acid.
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4. CLEPO 180-K Compound—Acid Powder to replace Nitric Acid for Desmutting Aluminum after Alkaline Etching.
5. CLEPO 180-S Compound—Acid Powder for Deoxidizing Aluminum Prior to Anodizing or Spot-Welding CLEPO 180-S is far superior to Nitric Acid for these purposes.

Contact us Immediately and we will arrange to have our local Service Man call on you and explain Operational Procedure.

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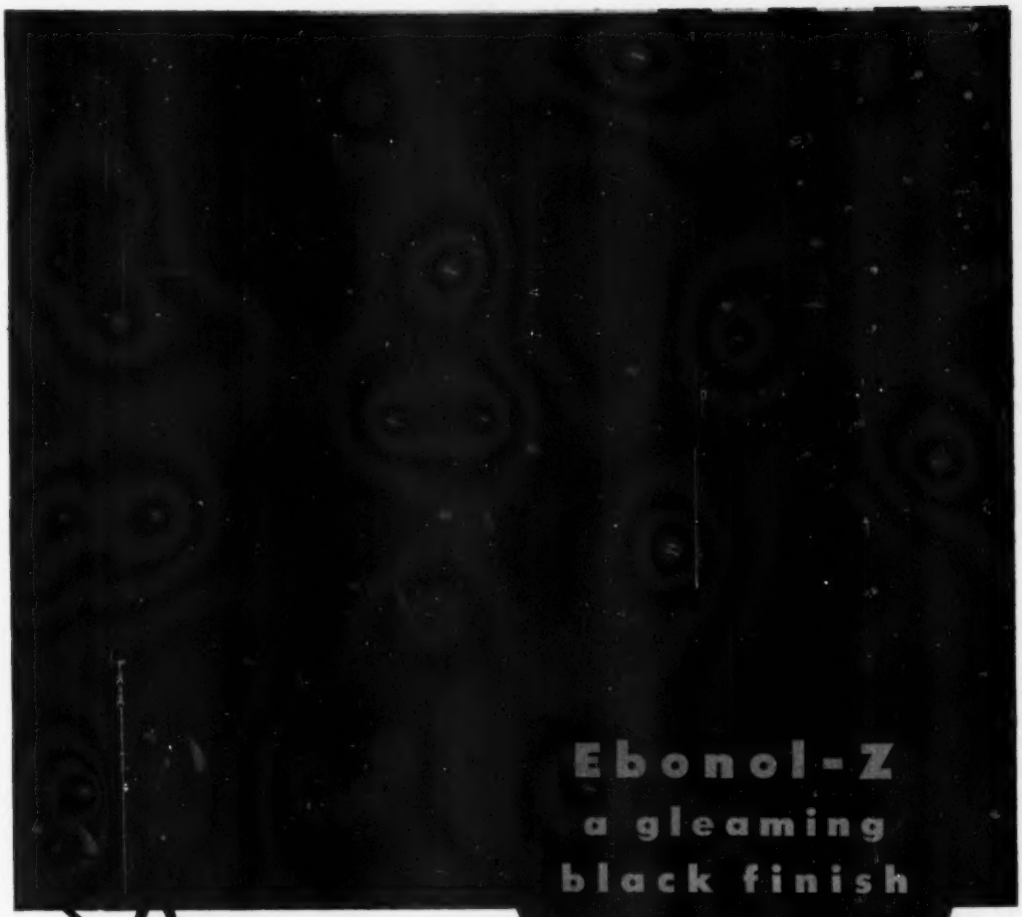

Beautiful, jet-black, like polished Ebony

These zinc automobile door handles are typical of the products processed in Ebonol-Z. This simple, one-dip method imparts to zinc base diecastings and plated parts, a rich, adherent black coating with good weathering qualities. Parts need only to be cleaned and then treated for a few minutes in a warm solution of Ebonol-Z. Chemical cost is one-half cent per square foot of the area coated . . . cheaper than plating or painting. Now used for finishing war materiel, and typewriters, business machines, toys, cameras, radios, name plates, buttons, and buckles.

Samples processed in our laboratory.
Detailed procedures supplied without obligation.

○ Ebonol-S for steel
○ Ebonol-C for copper and brass
○ Ebonol-Z for zinc

Write for check list . . .

Sixty Products and Processes for Metal Finishing

442 Elm Street, New Haven, Conn.

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THE

BULLSEYE

OF THE

METAL FINISHING INDUSTRY

Thirty-four of the forty-four branches of the AMERICAN ELECTROPLATERS' SOCIETY are located within a radius of 460 miles of BUFFALO. Milwaukee the most western point in the circle 460 miles—Boston the most eastern 440 miles.

BUFFALO the perfect vacation spot and the only Convention City in the nation with a World Wonder attraction—NIAGARA FALLS—HIGH AND MIGHTY IN ALL HER GLORY.

The papers to be presented at the BUFFALO A. E. S. CONVENTION will be most timely and particularly pertinent to the present problems in the METAL FINISHING FIELD.

While the men are busy at the Technical side of the convention, an excellent social program has been planned for the ladies and of course they will join in the social activities planned for the men.

Buffalo beckons with program to please
All in the coolness of Lake Erie breeze.
Knowledge is gained, and you have your fun
At Platers' Convention in fifty-one.

CONVENTION HEADQUARTERS

Thirty-Eighth National A. E. S. Convention
Buffalo, New York · July 30-31, August 1-2, 1951

PLATEMANSHIP

H-VW-M's unique combination of:

. . . the most modern and complete laboratory for testing and development

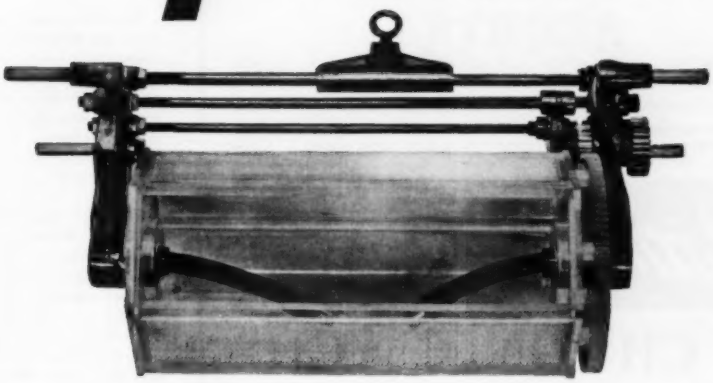
. . . ability to provide complete equipment and materials for every plating and polishing need

. . . the complete background of knowledge and experience in every aspect of plating and polishing.

LOOK TO H-VW-M *PLATEMANSHIP*

FOR THESE PLUS VALUES IN MERCIL TYPE PLATING BARRELS

- . . . **Availability in a variety of materials—Plexiglas, Merlon, Bakelite, hard rubber, depending upon the service**
- . . . **Smooth functioning under continuous production**
- . . . **Availability of cylinders in a variety of sizes and perforations with a wide choice of contacts**
- . . . **Tripple-tie-rod-hanger construction**



The wide variety of materials, sizes and contacts in which H-VW-M Plating barrels are supplied enables the user to select the exact type best suited to his needs. For example, Plexiglas cylinders with flexible danglers are recommended for operation through the entire cycle, acid or alkaline. Where increased production is the deciding factor, Merlon Ribless construction is supplied. If desired, barrels with pumping equipment are available to assure constant solution balance, thereby reducing the plating time.

What do these H-VW-M features add up to? Lower maintenance, lower production costs, a more uniform deposit—a better product more economically obtained. All these advantages are the result of *Platemanship*—H-VW-M's unique ability to meet and even anticipate the needs of the plating and polishing industry. They are covered specifically in Bulletin PB-107, ask for your copy.

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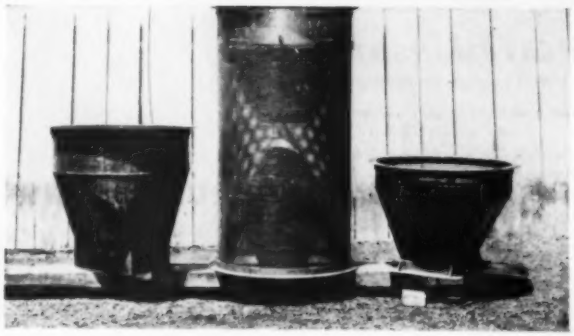

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Manufacturers of Welded Fabrications to Specification

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Mutual

CHROMIC ACID

OTHER NAMES: Chromic Anhydride, Chromium Trioxide

FORMULA: CrO_3

MOLECULAR WEIGHT: 100.01

DESCRIPTION: Deliquescent, dark red flakes. Bulk density averages 105 lb. per cu. ft.

CrO_3	99.75% min.
Chloride as Cl	0.01% max.
Sulfate as SO_4	0.1% max.
Insoluble in water	0.01% max.

USES: Chromium plating. Anodizing of aluminum. Metal surface treatment, including cleaning, pickling, etching, coloring and improvement of corrosion resistance and paint adherence. Pigment manufacturing. Organic oxidation syntheses, as in the production of dyestuffs and pharmaceuticals. Manufacturing other chromium chemicals and catalysts.

SHIPPING CONTAINERS: Steel Drums—100 lb. net.

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Industry News

Pennsalt Forms Maintenance Chemicals Department. The Pennsylvania Salt Manufacturing Company has formed a new sales department to serve industry and business in maintenance work, from heavy-duty cleaning of railroad equipment to cleaning of walls and floors in office buildings and institutions, it has been announced by William P. Drake, Vice-President in charge of sales. The new Maintenance Chemicals Department is headed by Horace F. McIntyre, a member of the Pennsalt organization since 1943 and formerly a sales representative, District Sales Manager and then Product Supervisor in the Special Chemicals Department.

Spectranome Plating Company has announced the opening of a modern plant, featuring completely automatic and conveyorized operations, at 330 W. 13th St. and 1-13 Gansevoort St., New York City.

Bart-Messing Corporation, manufacturer and distributor of plating and polishing equipment and supplies, has moved to 229 Main St., Belleville, N. J. The new plant has over 4 times the manufacturing space for Sel-Rex products than the previous plant in Brooklyn, and up-to-date laboratory, testing and manufacturing equipment.

DuPont's Experimental Station Addition in Wilmington, Del., was dedicated on May 10 before an assembly of some 200 distinguished academic and industrial scientists. The Station expansion includes a 57-acre area adjacent the original station, which was established in 1903. Nine new laboratory and 10 service buildings have been constructed, and 2 older buildings have been enlarged. The Station now has about 800 technically trained research workers and approximately 1500 nontechnical employees.

DuPont spent in 1950 $38,000,000, exclusive of construction costs, to support its research activities.

Wyandotte Chemicals Expands. A program to increase materially the manufacturing breadth and the industry-service scope of Wyandotte Chemicals Corporation, has been announced by Robert B. Semple, President. It will involve the company's three chemical manufacturing and compounding plants located in Wyandotte, Mich.; the limestone quarries at Alpena, Mich.; the montmorillonite clay operations at Blue Mountain,

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FULL LENGTH "CONDUCTA-CORE"
INCREASES CONDUCTIVITY, RIGIDITY

Federated Conducta-Core Lead Anodes have a highly conductive and non-contaminating 3/8" diameter aluminum rod running from top to bottom. This, together with the unique design of the anode, assures complete rigidity . . . there is no curling, buckling or peeling to interfere with automatic plating operations.

The Conducta-Core makes every inch of the anode highly and uniformly conductive . . . more current can be carried than by ordinary anodes. Another advantage of the Conducta-Core Anode is the great number of high projections that give it greater-than-average throwing power.

No need to worry about anodes dropping into the tank because of corroded hooks . . . an improved lead coating 3/16" thick at the base of the copper hook is your guarantee of permanently attached anodes.

Federated Conducta-Core Anodes are available in all standard lengths up to 52 inches, and with a variety of hooks. Special sizes made to order. Flat Rolled and 3-Rib Lead Anodes can also be supplied.

Federated Metals Division

Federated first in the non-ferrous field. FMD

AMERICAN SMELTING AND REFINING COMPANY • 120 BROADWAY, NEW YORK 5, N. Y.

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 456.

Industry News

Miss.; and the compounding plant at Los Angeles. Ground already has been broken for the new pilot plant and the Wyandotte Research Center. Additional production, research and technical facilities are included in the program.

The Metal Finishing Industry Action Committee of the Ohio River Valley Water Sanitation Commission met in Cincinnati during the week of January 22. Unfortunately A. E. S. President W. J. Neill was unable to attend, and the report of his sub-committee was presented by W. L. Pinner. This report included the work which has been carried out under Dr. Earl J. Serfass at Lehigh University since the scope of A. E. S. Research Project No. 2 was changed to include developments of analytical methods for plating room wastes. By resolution at the meeting, W. L. Pinner was instructed to convey to the American Electroplaters' Society Research Committee the sincere thanks of the Industry Action Committee and also of the Water Commission for the excellent cooperation extended them by the Research Committee.

Atlas Mineral Products Company has announced that **Ray Oster,** Hollingsworth Building, 606 S. Hill St., Los Angeles, Calif., will handle the sale of corrosion-resistant cements in the Los Angeles area and **Hugh G. Lawson,** 417 S. Hill St., Los Angeles, Calif., will handle the sales of jointing materials for water and sewer pipe in the same area. Both are well known in this territory.

The Chemical Institute of Canada. For three days, June 18, 19, and 20, Winnipeg will be the mecca for Canadian chemists and chemical engineers attending the 34th Annual Conference of the Institute. In addition to the 76 technical papers, attractions will include the presentation of the Institute's Medal for meritorious service to the profession, the delivery of the Leroy Egerton Westman Memorial Lecture, and plant visits.

Among the papers on the subject of protective coatings are: Determining fire-retardant values of surface coatings; Wax-type protective coatings for industry; and Modern red-lead paints.

Corrosion Course. Leading industrial authorities will join members of the M. I. T. faculty to present a one-week intensive course in corrosion at the Massachusetts Institute of Technology from June 18 to 23. The course will be under the direction of Dr. H. H. Uhlig, in charge of the Institute's Corrosion Laboratory. A knowledge of first-year college chemistry will be essential for participants.

Lectures are scheduled on "Fundamentals of Corrosion Reactions and Control"; "Metals and Alloys: Properties, and a Guide to Their Proper Selection"; "Cathodic Protection: Theory and Measurements", "Practice and Economics"; "Metallic and Organic Coatings: Selection, Application, and Behavior"; "Treatment of Environment"; "Design of Equipment from a Corrosion Standpoint"; "Principles and Practices of Corrosion Testing".

Those attending may reserve rooms in the Everett Moore Baker House. Further information may be obtained from Professor Walter H. Gale, Room 3-107, Massachusetts Institute of Technology, Cambridge 39, Mass.

Norton Company, Worcester, Mass., has made known the formation of the Norton Distributors' Advisory Council made up of representatives of eleven Norton abrasive distributors from Connecticut to California. Believed to be the first of its kind in the abrasive industry, the Council has been organized in an effort to obtain the benefit of the experience of representative distributor men. In the selection of men to serve on the 1951 Council, geographical location, size and type of distributor organization, and other factors were considered.

The American Hot Dip Galvanizers Association's Sixteenth Annual Meeting at the Biltmore Hotel in Atlanta, Ga., on

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Manufacturers of Iridite Finishes
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over one million amps of Sel-Rex PLATING POWER

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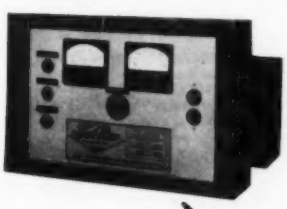
The largest single unit rectifier built to date is a Sel-Rex development. No matter how small or large your power requirements may be, Sel-Rex Rectifiers can be designed and built to suit your special needs. Being long experienced in the field of electroplating and electroforming is why we are rated top specialists in the industry when it comes to plating power.



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SELENIUM Sel-Rex RECTIFIERS

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Write in for your copy of our New 1951 Catalog on Schaffner's Buffing Compounds and Supplies

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The first consideration in today's Defense effort is speedier and easier racking for all plating, anodizing or conveyor parts. The correct NaRaCo rack design makes the difference between this speedier production and the unnecessary loss in man hours.

National Rack and the Imperial Plating Rack Companies have engineers actually experienced in all branches of the metal finishing industry. With this *know-how* you are assured of a practical design to solve even your most complicated racking problem.

Consult NaRaCo today for the fastest growing quality rack service in the country.

Serving Eastern Industrial Area
NATIONAL RACK COMPANY, INC.
179-181 Madison Street — Paterson, New Jersey

Serving Mid Western Industrial Area
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1613 Industrial Avenue — Flint, Michigan

Industry News

March 21 and 22, was one of the best attended in the Association's history, according to Stuart J. Swenson, Secretary-Treasurer. Approximately eighty members and their wives were present.

C. L. Moorman, of Equipment Steel Products Company, Blue Island, Ill., was elected President for the fiscal year 1951–1952.

Highlights of the meeting included a report by W. W. Hopton, Director of the Tin, Lead & Zinc Division of the N.P.A. Mr. Hopton spoke on "The N.P.A. Looks at the Zinc Picture". Mr. E. V. Gent, Executive Vice-President of the A.Z.I., delivered a paper, "Producer's Report on the Zinc Picture". Another speaker was Mr. Fred O. Reese of the Product Development Department of the Atlantic Steel Company, who spoke about "Manufactured Products for Galvanizing". The open forum discussion of galvanizing and plant problems produced a free interchange of experiences. New committee projects will deal with Plant Safety, Quality Control, Accounting, Experimental Tests, and other subjects.

The 54th Annual Meeting of the American Society for Testing Materials will be held in Chalfonte-Haddon Hall, Atlantic City on June 18–22, inclusive.

An important feature of the program will be the Edgar Marburg Lecture by Frank L. LaQue, international authority on corrosion, and in charge of the Corrosion Engineering Section, International Nickel Company, who will discuss corrosion testing.

Beginning Sunday, June 17, and extending through Friday, June 22, there will be an estimated 450 meetings of the various A. S. T. M. technical committees. Several of these committees have cooperated in developing the technical symposia featuring the A. S. T. M. program. Among them is a symposium on Bulk Sampling, sponsored by Committee E-11 on Quality Control of Materials. There will also be a separate session dealing with lead and its uses.

SALES ENGINEERS WANTED

Must be thoroughly experienced in all types of buffing and polishing. Should have a following. To represent a reputable firm in sales of well-established metal-center, unit-type buffing and polishing wheels, contact wheels, compounds, etc. Profitable territories available in Central States, Midwest, Southwest, and West Coast. Drawing account vs. liberal commissions. Permanent only. Send full particulars.

Reply to:
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P. O. Box 168, Jenkintown, Pa.

FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 460.

PENNSALT CHEMICALS

METAL CLEANING DIGEST

for busy people, interested in Metal Cleaning Economies

New Metal Cleaning Bulletin

A brand new bulletin dealing with the heavy duty cleaning of ferrous metals is just off the press. There are sections on soak tank cleaning, spray cleaning and electrolytic cleaning, as well as a wealth of other information . . . all on the subject of ferrous metal cleaning. Concisely written for the busy man, this new bulletin is brief and to the point.

(for a copy check #1 on the coupon)

PRODUCTION IDEA:

Pre-cleaning saves Alkaline Cleaners

Many metal finishing plants have found that both time and alkaline cleaner savings can be effected by pre-cleaning with an additional cleaning bath. By employing this additional step, users report the removal of heavy oil and grease deposits in the preliminary treatment. This in turn results in longer life for the final alkaline bath. Initial investment is not excessive, and total cleaning time is often actually shortened.

(for more information check #2 on the coupon)

Mail this coupon for more information on

#1_____ #2_____ #3_____ (B)

Name_____

Company_____

Address_____

City_____ Zone____ State_____

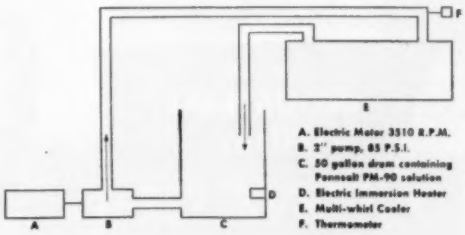
$700. Re-tubing job saved by descaling with Pennsalt Cleaner PM-90®

A recent service call by Bill Wilson, a Pennsalt service representative, resulted in a $700.00 saving for the customer, and put a heat exchanger back in service without re-tubing. Here's the way it worked:

A large bearing plant uses water tube quenching oil coolers. The equipment had been in service about 25 years without any maintenance attention at all. The scale from the river water used on the water side was caked so thick that feedwater at 85 p.s.i. came out as a thin trickle at the discharge end of the coils. Then to make things worse, water had been put through the oil side of the cooler and oil through the water side. In short, this cooler was ready for scrap.

But Bill Wilson asked for and got a chance to show what Pennsalt Cleaner PM-90 could do. First the oil was washed out with an alkaline solution. Then some concentrated PM-90 (a specialty acid type liquid descaler) was poured in to clear the way for circulation. This only required one gallon, although the shell capacity was about 30 gal. After soaking overnight in a dilute solution, circulation was started through the water side, as shown in the drawing. Results: Excellent! Practically all of the scale was removed from this heavily-encrusted cooler, and the foreman stated that a $700. re-tubing job would not be necessary. As a result, the customer is descaling 8 other coolers the same way.

(for more information check #3 on the coupon)

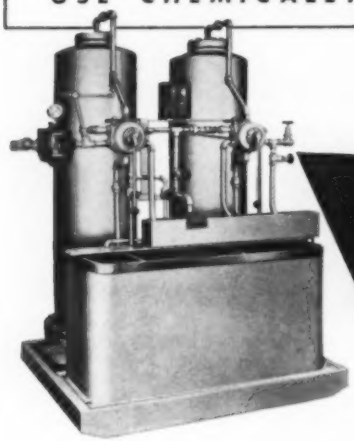


PENN SALT

PROGRESSIVE CHEMISTRY FOR OVER A CENTURY

Eliminate Hot-Rinse Stains Unwanted Precipitates

USE CHEMICALLY PURE WATER



only a few cents
a thousand gallons
with . . . .

INDUSTRIAL Water Demineralizers

A Two-Bed INDUSTRIAL Water Demineralizer. Standard two- and four-bed units available with capacities of 200 to 1000 gph. Special units of any capacity engineered to requirements.

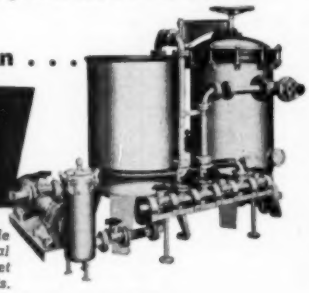
and it's as simple as it looks . . .

besides the extremely low cost, there is nothing complicated about getting the chemically pure water with Industrial Demineralizers. Raw water is passed through either two or four beds of ion-exchange resins and it comes out free of the dissolved mineral salts. No still, heat, steam, or cooling water is needed—keeping space requirements relatively small.

And it's simple to get the complete facts for your case. Send us a water analysis and let us know how much water you have to treat and the gallons per hour needed. We can then give you the whole demineralizer story including estimated costs, equipment required, performance data, etc. for your requirements.

for solution clarification . . .

use an **INDUSTRIAL Filter**



100 to 15,000 gallons per hour. Portable and stationary models. Standard or special filtration systems engineered to meet unusual requirements.

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RUBBER DIVISION Vulcanized Linings • Molded Products · WATER DEMINERALIZERS

Personals

Kenneth W. Montfort has joined Pennsalt of Washington as district sales representative. He will make his headquarters at the company's Portland, Ore., office and will devote his time to the sales and service of agricultural and industrial chemicals in Oregon, Colorado, Utah and Southern Idaho.

Mr. Montfort is a native of Blaine, Wash. He was Assistant Manager of Northwest Wholesale's Chemical Supply Department in Wenatchee, Wash.

Jacob W. Vreeland is now Chief Metallurgist of the Electroplating Anode Division of Wagner Brothers, Incorporated,

Vreeland

Detroit, Mich. He was previously associated in similar chemical and metallurgical capacities with McGean Chemical Company, The Harshaw Chemical Company, and Hanson-Van Winkle-Munning Company.

Howard Holt, a graduate of Park College, has joined the Technical Service Department; George Gabriel, formerly Assistant Plant Manager, has been promoted to Engineering Co-ordinator; and Gerald F. Gilbert, Jr., formerly Assistant to Technical Director, has been promoted to Product Director in charge of chemical-resistant cements, of Atlas Mineral Products Company, Mertztown, Pa.

W. Austin Bishop has been appointed to the Personnel Division staff of the Pennsylvania Salt Manufacturing Company. He comes to Pennsalt from the U. S. Army, where he was a Colonel in the Office of the Adjutant General. Prior to his army career, Mr. Bishop was coach of wrestling and a member of the faculty at the University of Pennsylvania, and from 1946 to 1948, before returning to the army, was Professor of Physical Education and Director of Athletics at Franklin and Marshall. He is a native of Manheim, Pa., and was graduated from Franklin and Marshall in 1927. He later took his M.A. (1934) and Ph.D. (1942) at New York University.

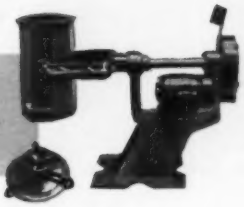
Carl L. Ipsen, Manager of General Electric's Industrial Heating Divisions at Schenectady, N. Y., has relinquished his duties in order to accept a position in

CROWN Equipment

Model 815 Selenium Rectifier

Crown Rheostat with Cut Out Switch

Crown Rheostat

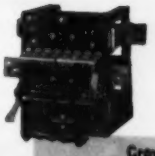

Ball Burnisher

Crown Tumble Finishing Machines

Centrifugal Drier

Partially Automatic

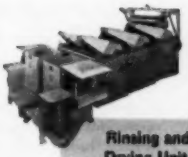
Fully Automatic Plating Machines


Crown Reversing Switch

Bottle Type Tumble Finishing Machine

Bench Type Utility Plater

Tilting Type Tumbler


Rinsing and Drying Unit

Crown Disconnect Switch

Plating Barrel

CROWN RHEOSTAT AND SUPPLY COMPANY

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MECHANIZE YOUR PLATING DEPARTMENT

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BUFFING AND POLISHING COMPOUNDS
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CEMENT AND THINNER
for setting up wheels, belts and rolls

HARRISON & COMPANY, Inc.
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FOR FURTHER INFORMATION, USE READER SERVICE CARD; INDICATE A 464.

BETTER THAN EVER

The True Insulator will give you more safety than before with the same standard of insulation as always. Wire braid hose on the ¾" and 1" sizes insures absolute freedom from failure. The ½" size has been completely redesigned to give higher quality with longer life. With all these improvements the True Insulator is a better bargain than ever.

THE TRUE INSULATOR

is specifically manufactured to insulate your plating operations from grounds and short circuits through the heating coils, cooling coils, air agitation systems or other pipe connections. The True Insulator provides more positive insulation than any other type known.

Available in following sizes

½ inch.....$7.00 per pair
¾ inch.....$7.50 per pair
1 inch.....$8.50 per pair

Quantity Discounts

TRUE BRITE CHEMICAL PRODUCTS
P. O. Box 31, Oakville, Conn.

PRACTICAL PRODUCTS FOR PRACTICAL PEOPLE

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Personals

an advisory capacity to the Machinery Division of the National Production Authority. In his absence, Mr. Ipsen's responsibilities will be assumed by **E. W. Cunningham,** who has been named acting manager of the Divisions.

Born in Randolph, Kan., Mr. Ipsen was graduated from Kansas State College in 1913 with a B.S. degree in electrical engineering. He joined G. E. later that same year. Mr. Cunningham is a native of Linton, Ind., and a graduate of Rose Polytechnic Institute at Terre Haute. He joined G. E. in 1927.

Robert D. Lawson has become Sales Manager of Norton Company's Grinding Machine Division. Chicago District

Lawson Ogg

Manager for the same division since 1946, he replaced **C. Denson Day,** who has resigned to accept a position as vice-president with Machinery Associates, Inc. of Philadelphia, Pa. Mr. Day had been with Norton Company since 1926. **Wilfred R. Ogg** has taken over the Chicago district managership April 16. He was until now New England sales representative for Norton grinding machines, a post taken over by **Louis J. Camarra** of the Foreign Division.

Mr. Lawson entered Norton employ in 1918 in the Engineering Department. He worked through various phases of machine sales until his appointment as Chicago District Manager five years ago. Mr. Ogg joined Norton Company following graduation from Dartmouth in 1935. Mr. Camarra has been associated with the company's Foreign Division since 1946—including a year spent as sales representative in South America.

L. E. Detre has accepted a position as Superintendent of Production of Enamel Products & Plating Company, McKeesport, Pa. He has in the past been associated with the Plating Departments of Thomas Steel Company and Brainard Steel Company of Warren, Ohio, and recently resigned his position as Plating Superintendent of Greer Steel Company, Dover, Ohio.

Raymond G. Ellis has been appointed to coordinate and direct the sales promotion and advertising of four associated

always better . . . better all ways . . .

New

COPPER FLAT-TOP

✓ better than ball anodes

● **Flat-Top,** the premium copper anode at a popular price, is SMOOTH! No gates or flash to hang on basket.

● **Flat-Top** has Greater Area. From 20 to 25% more effective area than the ordinary ball. More metal, less frequent loading.

● **Flat-Top** is Pure. No cavities to hide inclusions of copper oxide, silica or dirt. Manufactured from highest purity copper.

✓ better than oval anodes

● **Flat-Top** is "Good to the last molecule!" No waste, no annoying scrapping of "swords" and hooks. 100% efficiency.

● **Flat-Top** is Predictable! Eliminates rapidly changing anode area as ovals corrode, decreasing sludge formation and rough plating.

● **Flat-Top** is Ready! No delay, no extra costs of fabricating and attaching hooks. Load your tanks right from the keg.

Pass the Copper Flat-Top folder among the cost-conscious members of your organization. Just mail the coupon attached to your letterhead and you'll receive your copy. We'll also deliver a Gold Plated Copper Flat-Top paperweight – while our supply lasts.

✓ and copper Flat-Top is . . .

● **CLEAN!** Packed in new durable wooden kegs, protected from contamination of battered, used drums.

● **CONVENIENT!** Keg is safe to stack, easy to roll or truck. And all these **PREMIUM FEATURES** with substantial savings for you!

Wagner BROTHERS INC.

425 MIDLAND • DETROIT 3, MICH.

Send me a copy of your folder, the name of Wagner Brothers' representative in my area and a Gold Plated Flat-Top Paper Weight.

Name..... **Title**.....

Responsibility.....

Company..... **Street No.**.....

City..... **Zone**..... **State**.....

PHOSPHATE COATING CHEMICALS FOR SPECIFICATION FINISHES

METAL	GOVERNMENT SPECIFICATION	ACP SPECIFICATION CHEMICAL
STEEL	JAN-C-490, Grade I U.S.A. 57-0-2, Type II, Class C U.S.A. 51-70-1, Finish 22.02, Class C	"GRANODINE"
	U.S.A. 57-0-2, Type II, Class B U.S.A. 51-70-1, Finish 22.02, Class B	"PERMADINE"
	U.S.A. 57-0-2, Type II, Class A U.S.A. 51-70-1, Finish 22.02, Class A	"THERMOIL-GRANODINE"
ALUMINUM	MIL-C-5541 MIL-S-5002 AN-F-20 U.S. Navord O.S. 675 16E4 (Ships)	"ALODINE"
ZINC	QQ-P-416 RR-C-82 JAN-F-495 AN-F-20 U.S.N. Appendix 6	"LITHOFORM"

"GRANODINE"®

"GRANODINE" forms a zinc phosphate coating on steel and zinc surfaces. This non-metallic bond holds and protects the paint finish and thus preserves the metal underneath.

"PERMADINE"®

"PERMADINE" forms an oil-adsorptive zinc phosphate coating on steel, which, when treated with rust inhibiting oil, is highly corrosion resistant.

"THERMOIL-GRANODINE"®

"THERMOIL-GRANODINE" forms a manganese-iron phosphate coating on steel, which, when oiled, provides wear-resistance for rubbing parts — and, when oiled or painted, inhibits corrosion.

"ALODINE"®

"ALODINE", the new ACP protective coating chemical for aluminum, anchors the paint finish and protects the metal painted or unpainted.

"LITHOFORM"®

"LITHOFORM" makes paint stick to galvanized iron and other zinc and cadmium surfaces.

Write for more information on these products. Send for new descriptive folders on the ACP metal-protective, rust proofing and paint bonding chemicals listed in this advertisement.

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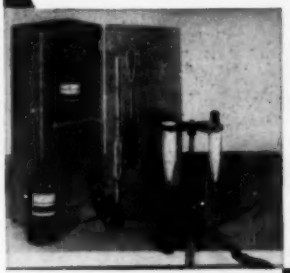
AMERICAN CHEMICAL PAINT COMPANY

AMBLER, PA.

Manufacturers of METALLURGICAL, AGRICULTURAL and PHARMACEUTICAL CHEMICALS

INCREASE YOUR PRODUCTION WITH KOCOUR PLATING TEST EQUIPMENT



All successful platers know that using KOCOUR plating test equipment means better plating, more production, lower costs, increased profits.

● The KOCOUR Sulfate Test Set enables anyone to accurately and quickly determine the sulfate content of a chromium plating bath in order to maintain a constant check on the ratio of sulfates to chromic acid. . . . This is important to insure consistently good plating results. . . . The entire test takes about 7 minutes . . . no calculations are necessary.

● The KOCOUR Chromic Acid Test Set was designed to accurately and simply determine the chromic acid content of chromium solutions. While a hydrometer is sometimes used for this determination, if close control is desired, the solution should be analyzed.

The set is self-contained . . . reads directly . . . is accurate to the one-half ounce per gallon of chromic acid . . . one simple subtraction is the only necessary calculation.

● Many platers use the KOCOUR Set "CR" for determining trivalent chromium in chromium solutions. The importance of this set is that a chromium solution high or low in trivalent chromium is not only expensive to operate but also is the cause of much spoiled work. The set is simple to operate . . . cost of upkeep small . . . no calculations are necessary.

● KOCOUR are specialists and pioneers in testing equipment for controlling plating — cleaning — pickling — anodizing — and hardening processes . . . special sets can be provided for your requirements.

Write today for further information—no cost or obligation.

KOCOUR COMPANY

4801 S. ST. LOUIS AVENUE

CHICAGO 32, ILLINOIS

Specify KOCOUR test sets from your supplier.

HD-N

Cuts Cleaning Time

Cowles HD-N Cleaner, the *new* heavy-duty soak cleaner for ferrous metals, will often do in 10 minutes what it takes other cleaners 30 minutes or more to do. It is specifically formulated as a straight or barrel soak for precleaning before plating, enameling, pickling, painting, back-shop reconditioning—or anywhere a heavy-duty cleaner is needed to remove stubborn types of soil.

The latest developments in metal cleaning research have been incorporated in HD-N to assure maximum detergency under all conditions of usage.

HD-N may also be used on such active metals as brass and zinc, if some attack is acceptable.

HD-N penetrates and removes such soils as oil, carbon, grease, drawing compound, graphite, road and shop dirt in *one* cleaning operation. It is fast, thorough, and does a complete job . . . is readily and completely soluble in hot water.

COWLES CHEMICAL COMPANY
Metal Cleaner Department
7016 Euclid Avenue • Cleveland 3, Ohio

This booklet will be sent by filling in coupon.

Cowles Chemical Company
7016 Euclid Avenue
Cleveland 3, Ohio

Please send me booklet, "HEAVY DUTY CLEANING THE FAST WAY."

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Company_____

Address_____

City_____ Zone____ State_____

FEEDING STEEL SHEETS into flat-polishing and coating equipment for pre-finishing before stamping.

3M Abrasives polish flat sheets prior to forming and plating!

"Pre-polishing" steel sheets in machines equipped with 3M Abrasive Belts boosts production. Flat stock passes under a series of grinding and polishing heads, at speeds up to 40 feet per minute.

Pits, seams, slivers and other surface imperfections are removed while the steel is in the sheet, coil or blank form. Tough aluminum oxide coatings of the abrasive belts finish the stock to smooth perfection. After forming, parts are then ready for plating or painting. Tedious hand polishing is eliminated.

3M Methods and 3M Abrasive Belts can cut *your* finishing costs. Send the coupon below for full information.

Minnesota Mining & Mfg. Co. Dept. P651
St. Paul 6, Minn.

☐ Please send me latest report on "pre-polishing."
☐ Please have a 3M Methods Engineer call.

3M ABRASIVE BELTS

Name.....

Firm.....

Address.....

City.....Zone...State.....

Made in U.S.A. by MINNESOTA MINING & MFG. CO., St. Paul 6, Minn., also makers of "Scotch" Brand Pressure-sensitive Tapes, "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-Slip Surfacing, "3M" Adhesives. General Export: Durex Abrasives Corp., New Rochelle, N. Y. In Canada: Canadian Durex Abrasives Ltd., Brantford, Ontario.

Personals

companies, Sel-Rex Precious Metals, Inc.; Bart-Messing Corporation; Bart Laboratories Company, Inc.; and Bart Manufacturing Corporation. He was formerly

Ellis

Advertising Manager of the Electrochemical Society's Journal, and is the author of articles on sales stimulation and improved manufacturing procedures.

Robert C. Allen has been appointed Treasurer and **Alan R. Burman,** Vice-President of the Cro-Plate Company, Hartford, Conn.

Mr. Allen, a C. P. A., comes from the Springfield, Mass., office of Miller, Morgan & Company, accounting firm. He is

Burman

a graduate of American International College and holds a Master's degree in Business Administration from Boston University. Mr. Burman comes from Wilson, Haight & Welch, Inc., Hartford advertising agency. He will head a new advertising and sales department.

Warner E. Remington, formerly Assistant Chief Manufacturing-Development Engineer of AC Spark Plug Division, Flint, Mich., is now Chief Manufacturing-Development Engineer. He was recently elected president of the Saginaw Valley Branch of the American Electroplaters' Society.

WANTED

Assistant Foreman for small but growing Paint Department of established plating concern in North Ohio. Should know how to set up jobs and be familiar with production procedures. Give age, background and salary required. All replies confidential. *Reply to:*

P-651-B, PLATING
P. O. Box 168, Jenkintown, Pa.

News about UNICHROME Trade Mark COATINGS for METALS

If you can use zinc you can bright-finish

A decorative finish that looks like chromium is easily obtained by processing zinc plate in Unichrome Clear Dip. Since all you need is .0003" of zinc plate, you can make the zinc available to you go further and still provide a good quality, selling finish.

* * *

Your copper tank can be used for "Stopping-Off"

Users of Unichrome Pyrophosphate Copper Plating Process know that it provides fast, dependable stopping off of steel parts in carburizing and nitriding operations. Ask us for details.

* * *

A black dip for zinc that's glossy and uniform

Make use of your plating equipment to get a metallic finish that looks as good as black enamel. This new Unichrome Dip for zinc plate has good gloss; uniformly dense blackness; and increases the rust protection of zinc plate on steel.

* * *

How to save money on painting

Plating plants need extra rugged protection against moisture and chemicals – and get it with Ucilon Protective Coating Systems. Applied to tanks, ducts, walls, piping, tough Ucilon Coatings are helping many concerns maintain equipment in attractive condition, while reducing frequency and expense of painting.

Plating speeded up where it counts most today — in HARD CHROMIUM

Unichrome S.R.H.S. Chromium Bath plates faster, smoother – steps up production without extra equipment

Because of defense orders, you'll see more hard chromium plating being done nowadays than has been for years. And it's being done 20 to 80% faster, too – in Unichrome S.R.H.S. Chromium.

Piston rings, for example, are being plated in S.R.H.S. Chromium by one company in only 3½ hours. It took 5 hours in ordinary chromium. A large plating plant cut plating time on aircraft brake discs from 65 minutes to only 40 minutes by means of S.R.H.S. Chromium. Still another concern is depositing chromium at the fast rate of .0025" per hour on gun turret, engine and other vital aircraft parts.

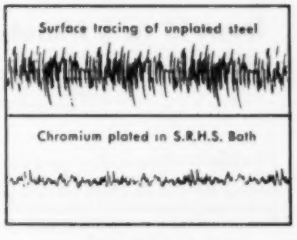
Unichrome S.R.H.S. Chromium not only permits you to plate more tank loads of work per day but often it increases the number of pieces which can be plated *per cycle*. It increases capacity of equipment, reduces load on generators.

SELF REGULATION SAVES TIME AND TROUBLE

Especially valuable for hard chromium is the unique self-regulation of Unichrome S.R.H.S. Chromium. This feature provides peak throwing power with less supervision – assuring good coverage on difficult parts and iron castings.

SMOOTHER PLATE SAVES FINISHING

Because of its superior leveling action, Unichrome S.R.H.S. Chromium smooths over minor surface irregularities in the base metal, as shown by the surface traces below. Therefore, S.R.H.S. Chromium deposits require less grinding and final finishing. For this reason, the amount of chromium you deposit in excess of final requirements can be decreased, resulting in a substantial saving of plating time.



WHAT MASKING TO USE

Stop-off *lacquers* serve you best on large areas that can be sprayed or brushed. Stop-off *compounds* for dipping save time and work on complicated shapes Unichrome Tape can be used on the spot. No matter what the requirement, you'll do an easier, more dependable job with one of the various Unichrome Stop-Offs for all plating conditions.

* * *

Remember, if you are chromium plating now, or expect to do so for defense orders, contact "Headquarters for Coatings for Metals." Let our engineers show you how to meet specifications with speed, economy and minimum rejects.

UNICHROME Trade Mark

UNITED CHROMIUM, INCORPORATED

100 East 42nd St., New York 17, N. Y.
Detroit 20, Mich. • Waterbury 20, Conn.
Chicago 4, Ill. • Los Angeles 13, Calif.
In Canada:
United Chromium Limited, Toronto, Ont.

Trade Literature

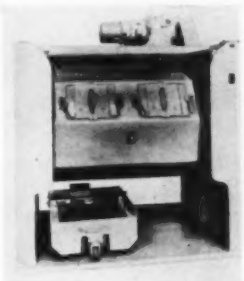
L—608. Surface Preparation of Metals for Black Oxide Finishing—Helpful data on materials and procedures that produce the chemically clean surfaces required for black oxide finishing of metals is presented in a special Service Report available from Oakite Products, Inc., 140 Thames St., New York 6, N. Y. It reviews in detail recommended materials and methods for (1) alkaline cleaning of ferrous metals to remove light soils; (2) solvent cleaning where heavier soils must be removed; (3) electrocleaning ferrous metals to remove carbon smuts and other coatings; (4) rust and scale removal; (5) controlling acid solutions when pickling iron and steel; (6) tank-cleaning of nonferrous metals; and (7) electrocleaning of nonferrous metals. A hot-oil-bath treatment for black-oxide coated parts that enhances the finish and provides effective anti-rust protection, and materials and methods for stripping black finishes from iron and steel and nonferrous rejects are also described. For your copy, use Reader Service Card.

L—609. Polishing, Buffing—J. J. Siefen Company, 5657 Lauderdale Ave., Detroit 9, Mich., offers a 3-color illustrated booklet describing its materials, equipment and services. Special attention is given to the Siefen System for application of liquid buffing compounds, Nu-Spray-Glue. For your copy, use Reader Service Card.

L—610. Air-drying Enamel Finish—Bulletin 239 describes the advantages in using the new Neolac "600" enamel finish developed by The U. S. Stoneware Company, Akron 9, Ohio. It contains no lead, is made with a new resin C-34 that is said to give fast drying, hard finish, high gloss, and outstanding weather ability. The 4-page, 3-color bulletin also gives complete instructions for applying the finish. For your copy, use Reader Service Card.

L—611. Abrasive Cloth Specialties—B-M Bulletin, Vol. 10, No. 1, issued by Behr-Manning, Troy, N. Y., describes a variety of specialties made from Metalite abrasive cloth for hand-finishing, including cylinders, spiral points, cones, cords, pads and disks. It also shows special applications of abrasive belts. For your copy, use Reader Service Card.

L—612. Tumble Finishing Machines—A complete catalog covering improved tumbling machines and auxiliary equipment has been issued by Crown Rheostat & Supply Company, 3465 N. Kimball Ave., Chicago 18, Ill. These machines are said to be used almost universally in aircraft, armament and other metal-working industries to debur and smooth rough edges and sharp corners at low cost.



Featuring Crown "Buffer Strip Lining" which makes possible on-the-spot replacement, these machines keep at a minimum the down-time needed for lining renewal. Semi-soft rubber linings are also available. A variable-speed drive gives the operator a wide choice of speeds for the processing of steel, die cast or other metal parts. An automatic timer control assures a definite operating time thus avoiding the over- or under-running of work during the processing period. Added features include lightweight doors with "full-grip" door lock handles and a water-tight door seal. For your copy, use Reader Service Card.

L—613. Metal Cleaner—Four metal cleaners are discussed in a new booklet, "Heavy Duty Cleaning—The Fast Way", released by Cowles Chemical Company, 7016 Euclid Ave., Cleveland 3, Ohio.

The booklet was especially designed to explain how and why operating time can be cut and cleaner costs lowered when Cowles HD-N Cleaner is used in heavy-duty metal cleaning. It points out types

CASE HISTORIES

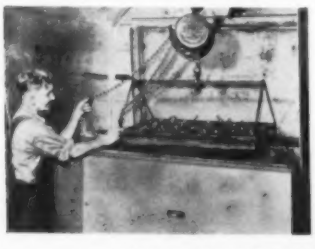
Actual Reports Available on Request

Pre-Cleaning Time Cut from 15 to 5 Minutes in Job Plating Shop

Problem: Removal of coolant and cutting lubricants, chips and shop dirt from small screw-machine parts prior to alkaline platers' cleaning.

Former Method: Baskets of parts placed in vapor degreaser for 15 minutes to remove soil.

Present Method: Baskets of parts are immersed for 5 minutes in Magnusol Pre-Cleaning solution heated to 175°F. (The Magnusol emulsion is made by mixing 1 gallon of Magnusol with 10 gallons of mineral spirits and 20 gallons of water.) After 5 minutes to soak, the parts are given a quick water rinse and then placed in the alkaline platers' cleaning cycle.



Advantages: Using the hot Magnusol emulsion, the pre-cleaning cycle has been shortened from 15 to 5 minutes. Parts are completely cleaned, ready for the subsequent cleaning and plating operations.

The Magnusol method is low in cost and can be readily incorporated into many present cleaning cycles with relatively little trouble. Rejects due to improper cleaning can be literally reduced by the hundreds. Why not consider it for your shop? For information write Magnus Chemical Co., 41 South Avenue, Garwood, N. J. In Canada—Magnus Chemicals Limited. Montreal. Service representatives in all principal U. S. cities.

37th Annual Proceedings

Volume of Technical and Scientific Papers Presented During the 1950 A. E. S. Convention Including Discussions

The Self-regulating High-speed Chromium Plating Bath; Nodule Method of Measuring Adhesion of Electrodeposits; Advances in Electrodeposition in the Graphic Arts; High-Speed Nickel Plating of Curved Stereotypes; Methods of Measurement of Surface Smoothness; Smoothing by Electropolishing and Chemical Polishing; Leveling with PR Current Plating; Some Observations of the Microthrowing Power of Plating Solutions; Leveling in Cobalt-Nickel Solutions; Surface Contour and Leveling; General Discussion of Leveling, including Mechanism of Electropolishing, Leveling in Barrel Zinc Plating, Leveling in a Variety of Plating Baths; Metal Finishing by Abrasive Tumbling; Abrasive-Belt Polishing; Flat-polished Phosphate-coated Steel Reduces Polishing Cost; Water-Base Buffing Liquid; Reporting and Use of Research Data; Why Pay for Porosity Research (discussion); Use of Radioactive Isotopes for Determination of Current Distribution.

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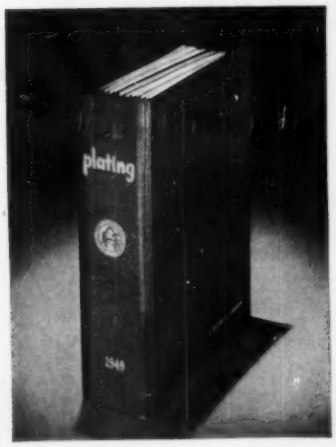
12 issues of PLATING snap into place in this beautiful maroon fabrikoid-covered binder. It always opens flat, just like a book, whether it contains one or twelve issues.



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I enclose $.....(check or money order) for which please send binders postpaid as checked above. I have included 60c for my name on each.

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$2.50 U. S. A. POSTPAID
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Available for Immediate Shipment Attractive Values

THE FOLLOWING EXCELLENT REBUILT AND GUARANTEED ELECTROPLATING MOTOR GENERATOR SETS AND RECTIFIERS, WITH FULL CONTROL EQUIPMENT:

1—12,000/6000 AMPERE, 12/24 VOLT, BRAND NEW **COLUMBIA**. Synchronous Motor. Complete Controls.

1—6000 AMPERE, 2-6 VOLT, **JANTZ AND LEIST**. Separately Excited. Excellent Condition.

1—6000/3000 AMPERE, 6/12 VOLT, **CHARLES J. EDGUE**. Synchronous Motor.

1—5000/2500 AMPERE, 10/20 VOLT, **HANSON-VAN WINKLE-MUNNING**. Exciter-in-Head. Synchronous Motor.

1—5000/2500 AMPERE, 6/12 VOLT, **EAGER ELECTRIC CO**. Separately Excited. Excellent Condition.

1—3000/1500 AMPERE, 12/24 VOLT, **HANSON-VAN WINKLE-MUNNING CO**. Synchronous Motor. Exciter-in-Head. Excellent Condition.

1—2000/1000 AMPERE, 6/12 VOLT, **A. P. MUNNING "OPTIMUS."** Excellent Condition.

1—1500/750 AMPERE, 6/12 VOLT, **HANSON-VAN WINKLE**. Excellent Condition.

1—1000/500 AMPERE, 6/12 VOLT, **ELECTRIC PRODUCTS CO**. Separately Excited. Excellent Condition.

1—2000 AMPERE, 50 VOLT, **CHANDEYSSON ELECTRIC CO**. ANODIZING UNIT. Synchronous Motor. Full Controls.

1—1500 AMPERE, 40 VOLT, **HANSON-VAN WINKLE-MUNNING CO**. Anodizing Unit. Complete Controls. Synchronous Motor. Excellent Condition.

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1—400 AMPERE, 40 VOLT **"M.G.C."** Anodizing Motor Generator Set. Exciter-in-Head.

5—**GREEN SELECTROPLATERS**, 1800 AMPERES, 12 VOLTS, for operation on 220 volt, 3 phase, 60 cycle.

1—**GENERAL ELECTRIC CO. COPPER OXIDE RECTIFIER**. 2000 AMPERES, 6 VOLTS. With 220 volt 3 phase, 60 cycle input.

2—**UDYLITE-MALLORY RECTIFIERS**, 1440 AMPERES, 6 VOLTS, with 220/440 volt, 3 phase, 60 cycle input.

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M. E. BAKER CO.

25 WHEELER STREET
CAMBRIDGE, MASS.

Trade Literature

of soil removed and the physical and chemical methods used in their removal. HD-N is discussed fully, along with Cowles LP Cleaner for removing buffing and drawing compounds, Cowles SK Cleaner for oil, fat and grease removal, and Cowles LIXOL Cleaner for use in pressure-spray washers. For your copy, use Reader Service Card.

L—614. Buffing and Polishing Compositions—Lasalco, Inc., 2818-38 La Salle St., St. Louis 4, Mo., offers a 20-page catalogue describing its line of polishing and buffing compounds. It begins with a cross-reference chart for determining the types of material recommended for polishing, buffing, bright-finishing and satin-finishing of various metals and nonmetallics, and continues with separate sections on each type, in which are given the various grades within the type, their characteristics and detailed applications. Data on wheel speeds and a list of other Lasalco products complete the catalogue. For your copy, use Reader Service Card.

L—615. Steam Detergent Cleaning—A discussion of how steam-detergent cleaning saves time and work and helps cut costs of industrial maintenance is provided in an illustrated folder available from Oakite Products, Inc., 140 Thames St., New York 6, N. Y.

Three different actions take place simultaneously, namely, (1) the physical action of steam and hot water working their way through successive layers of grease and dirt; (2) the dissolving action of heat on oils, greases and other deposits; and (3) the chemical action of the detergent in penetrating, wetting and emulsifying surface deposits. Typical instances where this method offers substantial time and work savings in equipment clean-up operations are enumerated, detailed specifications of the types of steam-cleaning equipment available are given, and helpful data on the preparation of efficient working solutions are offered. For your copy, use Reader Service Card.

L—616. Electroplating Iron—A description of the solutions and methods is available from the Hanson-Van Winkle-Munning Company, Matawan, N. J.

Iron has been recommended for use as a plated coating both on its own merits and as a substitute for scarce materials. It will be found particularly applicable in the graphic arts and electro-forming fields, as a substitute for copper or nickel.

It can also be used in the resizing of worn or mismachined parts and for coating of conducting and nonconducting materials. For your copy, use Reader Service Card.

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GLASS FIBER TANKS

★ *For ACIDS*

★ *For PLATING SOLUTIONS*

★ *For LUSTER-ON® ZINC DIPS*

★ *For EMULSION CLEANERS*

Fiberglas® impregnated, bonded with resins and molded into a one-piece seamless tank, Pla-Tank is being acclaimed everywhere as the ideal electro-plater's or chemical processing tank.

PLA-TANK

orders are increasing daily for uses which formerly required stainless steel, plastic or rubber-lined tanks, acid-proof stoneware or crocks. Write for list of current sizes.

PLA-TANK

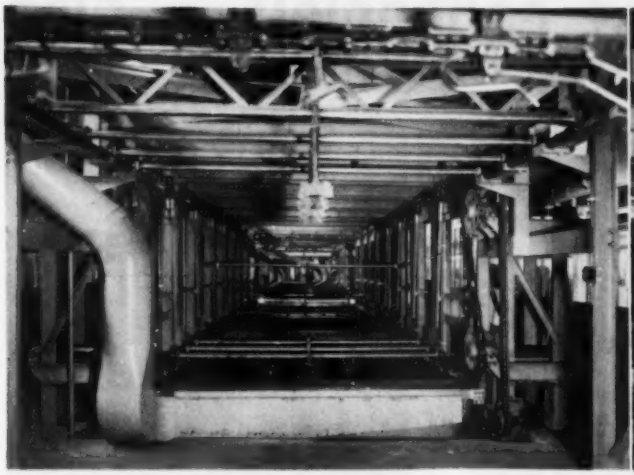
is especially suited for Chemical Corporation's Luster-On Bright Dip and new Luster-On Light Khaki — both widely used since NPA bans on the use of cadmium and nickel.

PLA-TANK

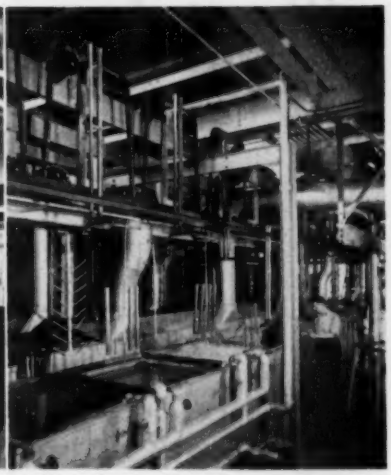
can be patched in minutes — on the job — in case of severe physical damage. Free data sheets will be sent on request, and engineering consultation is available for conversions. Address inquiries to:

THE *Chemical* CORPORATION
37 Waltham Ave., Springfield 9, Mass.

in your plating How to Get Greater Production Improved Quality Better Working Conditions

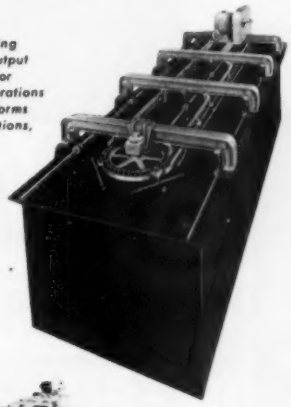


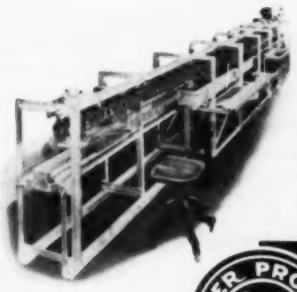
Typical Meaker Straight-A-Way Automatic Plating Machine. This type unit is designed to handle 125 racks or more per hour.



Meaker Return-Type Automatic Plating Machine for chromium-plating the large variety of parts in a high-quality line of plumbing hardware. Machine may be designed to copper plate, nickel plate, and chromium plate in one continuous line.

A Meaker Semi-Automatic Plating Machine for use in medium-output plating departments and also for supplementing the plating operations in a Full Automatic which performs the cleaning, preplating operations, final rinsing and drying.





A special machine designed by Meaker for cleaning and silver plating small, brass contact clips.

You Get All Three with Meaker

Here's how! A Meaker plating machine makes every operation in the plating sequence automatic, or as mechanized as possible. This cuts to a minimum the manual handling of the parts in process—increasing production. The control of the quality of the plating is set and practically independent of the varying human element. A Meaker plating machine does clean up the plating room making for safer and more agreeable working conditions. And a bonus—in many cases the savings in the over-all plating costs have paid for the equipment in a short time.

Look to the handling methods in your plating department. You might be surprised what modern methods will accomplish. Whatever your requirements—full automatic, semi-automatic, or a special machine—Meaker has the answer.

MEAKER PRODUCTS

Serving the Plating Industry for Over 50 Years

THE MEAKER COMPANY

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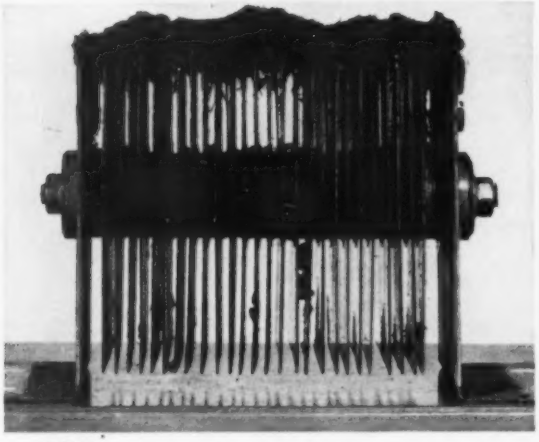
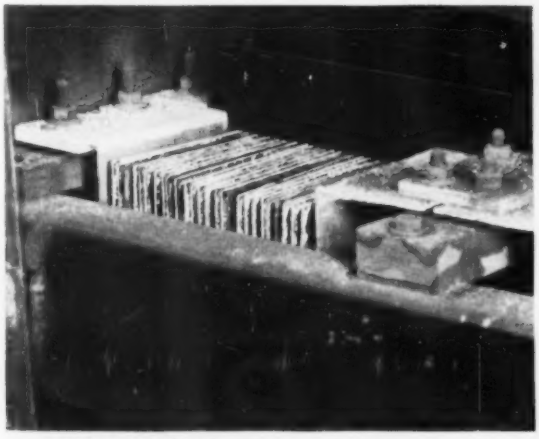
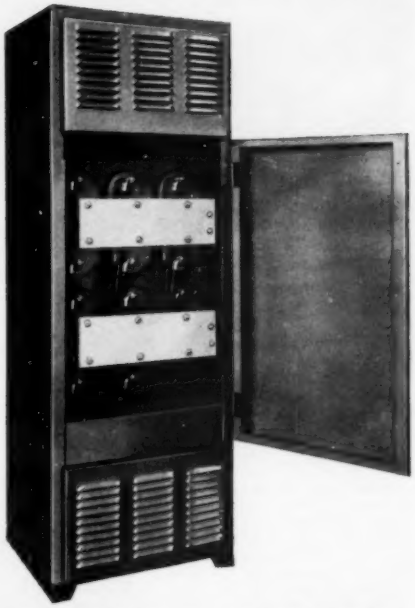
NOW LOCATE RECTIFIERS ANYWHERE without fear of CORROSION or DIRT



DIRT from sweeping and buffing operations has ruined this stack. The photo shows an unprotected stack removed from an ordinary plating rectifier which was in a poor location.



CORROSION damaged this stack which was placed too close to tanks. Fumes can impair open stacks in a short time if rectifier is improperly located.



G-E SELENIUM STACKS ARE SEALED IN OIL

Oil-immersed, hermetically sealed, G-E selenium rectifiers give you complete freedom of plating room layout. Place them anywhere, and forget about corrosion and dirt.

Stacks of G-E selenium rectifiers are factory sealed in oil-filled cans, with covers welded in place. Neoprene-sealed, glazed-porcelain terminals complete the seal—make sure that corrosion and dirt don't get in.

For real power savings investigate G-E rectifiers now. Contact the rectifier specialist at your local G-E office or write Section 464-6, *General Electric Company, Schenectady 5, N. Y.*

You can put your confidence in—

GENERAL ELECTRIC

464-6

Equipment and Supplies

E—689. Chemical-resistant Work Clothing—Work clothing (shirts, trousers, and coveralls) made of Union Carbide and Carbon's new staple fiber, Dynel, is reducing clothing replacements in acid and caustic plant operations by as much as 75 per cent, according to customer reports received by Chem Wear Inc., 740 Broadway, New York City, makers of the clothing.

Courtesy Carbide & Carbon Chemicals Company, Division of Union Carbide & Carbon Corporation

Chem Wear Dynel clothing is said to look and feel like fine flannel. It is not merely a "treated" fabric, but remains acid and caustic resistant permanently. The shirts in the picture (left, cotton; right, Dynel) were agitated in 60 per cent sulfuric acid for two minutes, washed and dried.

In a series of laundering tests subjecting Chem Wear to many hours of continuous washing in strong caustic soap, all the garments survived intact, unweakened, and ready to wear. Dynel will not support combustion. For further information, use Reader Service Card.

E—690. Neoprene Coatings—The Atlas Mineral Products Company, Mertztown, Pa., which pioneered the development of liquid Neoprene coatings, has now improved its product so that it is readily sprayed and is fast-curing at ordinary temperatures. This product, which possesses the chemical resistance for which Neoprene is noted, is available both as a high-solids spraying solution and as a trowel cement. It is sold under the name of Neobon and is being used throughout industry to protect against abrasion and corrosive solutions. Neobon is available in experimental quantities and unlimited quantities with proper priority ratings. For further information, use Reader Service Card.

E—691. Submerged-Finishing Machine—The Almco Supersheen submerged-finishing machine, Model SB-1, manufactured by Almco, Division of Queen Stove Works, Inc., Albert Lea, Minn., is said to handle a wide range of parts, particularly heavy parts and large soft-metal parts. The cushioning effect which results from the complete immersion of the barrel lessens the impact between large parts to such an extent that nicking and scratching are kept to a minimum. Another adaptation is in the processing of smaller parts requiring the utmost in color and micro-inch finish.

The perforated steel drum revolves in an open tank of liquid. The drum is loaded with work parts and the abrasive chips or metal shapes. Various liquid compounds are used in the tank depending on whether the operator is to burnish, polish, clean, descale or rustproof.

ARE YOU ONE ?
OF THE HAPPY USERS OF
GRIPMASTER
POLISHING WHEEL CEMENT
"First Choice of the W
ARE YOU using valuable work space storing complicated inventories of adhesives ?
ARE YOU losing time on frequent wheel changes ?
GRIPMASTER'S ONE GRADE answers your polishing problems.
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YOUR FREE SAMPLE
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NOW! Use Wyandotte Metal Cleaner No. 5 for All These Applications!

- *Immersion cleaning**
- *Rotary washer cleaning**
- *Tumble barrel cleaning**
- *Pressure spray washer cleaning**
- *Electrocleaning**
- *Maintenance cleaning of concrete surfaces*

**Ferrous and nonferrous metals*

Wyandotte Metal Cleaner No. 5

"Cleaning the World"

--a dustless, ▶
free-flowing, ▶
all-soluble ▶
cleaner ▶

IF ANY of the applications listed here are yours, ask your Wyandotte Representative to demonstrate Metal Cleaner No. 5. He'll probably prove to you that your present cleaning costs are higher than they should be. While your present cleaner might be doing a good enough job, Metal Cleaner No. 5 can do it better—and more economically! From copper to concrete, you can cut costs and get cleaner surfaces with Metal Cleaner No. 5. Try it!

P.S.—If you're having a cleaning problem of any type, write Wyandotte for free technical information and service.

- *Holds its strength in solution, which reduces cleaner costs*
- *Has superior detergency on all types of soils*
- *Rinses freely*
- *Is well inhibited*

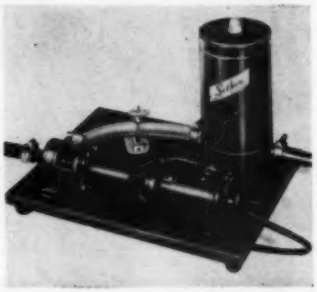
THE WYANDOTTE LINE—products for burnishing and burring, vat, electro, steam gun, washing machine and emulsion cleaning, paint stripping, acid pickling, related surface treatments and spray-booth compounds. An all-purpose floor absorbent: Zorball. In fact, specialized products for every cleaning need.

WYANDOTTE CHEMICALS CORPORATION
WYANDOTTE, MICHIGAN
Service Representatives in 88 Cities

Wyandotte
REG. U. S. PAT. OFF.

This model is for use alone or for multiple-operation processing. For instance, an in-line installation consisting of six tanks would include a combination cleaning and deburring operation, rinse, descale, and deburr at one time, rinse, burnish, hot rinse, or the rustproofing step. In such an arrangement, the drum is loaded with parts and abrasive chips and is moved from one tank to another. A special separating screen is available for the end of the "line". For further information, use Reader Service Card.

E—692. Filter—Sethco, 105-07 150th St., Jamaica, N. Y., announces a new filter-pump unit, Model HHUE-5. It is equipped with an asbestos-impregnated furfuryl-alcohol-resin filter cylinder and a Hastalloy pump and fittings, and is rated for filtering at 50 gph. Filter element is a specially processed cotton yarn



wound around a stainless-steel supporting core. Porous stone and porous carbon filter tubes are furnished for concentrated acid and concentrated alkali solutions, respectively. Filter tubes may be used over and over again.

Advantages claimed are: (1) Complete resistance to all electroplating solutions, including all acids and alkalies and an impressive list of solvents, including the chlorinated aromatic compounds; (2) solutions up to 265° F (130° C) can be filtered continuously or intermittently; (3) no loss of expensive solution; (4) filter tube can be backwashed or washed; (5) crystal-clear filtration with removal of even the finest particles; (6) simple operation. For further information, use Reader Service Card.

E—693. Masking Tapes—Behr-Manning Corporation, Troy, N. Y. (Division of Norton Company) offers a new line of paper-backed, pressure-sensitive tapes under the trade name Behr-Cat Brand Masking Tapes. Designed for a wide variety of applications, they are adapted to masking, as in spray or brush painting; stencilling, as in screen or stencil painting; packaging, sealing, holding, labeling, and surface protection in transit.

Correct tackiness for faster application, better flexing to contours, dead-stretch that prevents creep-under of

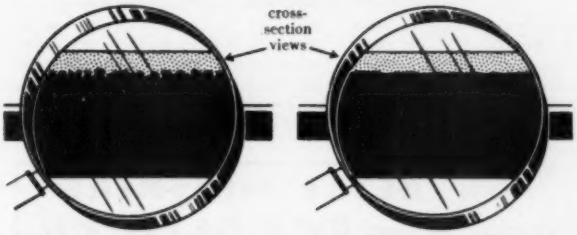
RACK COATINGS that are bonded RIGHT

The bond is stronger than the coating itself . . . just try to pull the coating from a rack that has been sandblasted.

Another reason why BELKE Racks Cost Less to Use

BELKE-Developed Processes bond the coating to the metal with a bond that is stronger than the coating itself. The BELKE Bond is not weakened by continuous temperature changes and flexing of tips. It provides unequalled protection against seepage between coating and metal.

It takes *SANDBLASTING* to Make a GOOD BOND



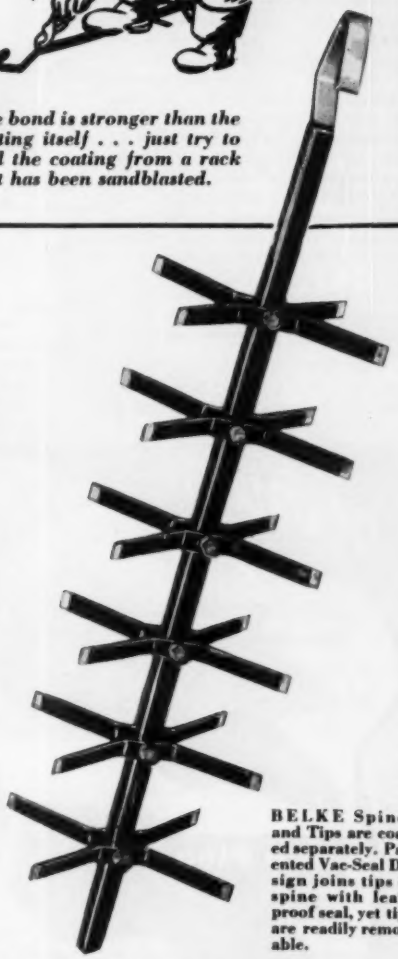
Sandblasting produces irregular surfaces with deep recesses—the ideal foundation for a strong bond between metal and coating — free from unbonded spots to cause blisters.

Acid Dipping produces relatively smooth surfaces with shallow recesses — a poor foundation for bonding coating to metal. Spots of poor adhesion are practically unavoidable.

RESULTS TALK!—First pull the coating from an acid dipped rack . . . then just try to pull the coating from a BELKE Rack. You'll see why BELKE Racks cost less to use.

Sandblasting is just one of the extra quality features that makes possible the longer service life you get with BELKE Coatings.

For quotation on coating or making racks, just send sample rack or dimensional print with complete information . . . or consult a BELKE Service Engineer.



BELKE Spines and Tips are coated separately. Patented Vac-Seal Design joins tips to spine with leakproof seal, yet tips are readily removable.

most complete RACK MANUAL ever produced

Dozens of War Items

100 pages. 560 Proven Designs of Racks, Tips and Hooks. Shows how to rack everything from jewelry to bumper bars. Price $5.00 post paid.

Belke MANUFACTURING CO.
947 N. Cicero Ave.
Chicago 51, Ill.

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Equipment and Supplies

paint, thinness that prevents build-up of paint, ideal performance in high temperature work, better balance between tensile strength lengthwise and tear strength crosswise, and "no residue" strip-off in unmasking, are among the benefits claimed. For further information, use Reader Service Card.

E—694. Polishing Grease Sticks—Hanson-Van Winkle-Munning Company, Matawan, N. J., announces the development of a line of polishing tallows containing entirely new raw materials.

Tallow 5B41 is said to have excellent lubricating qualities, medium-high melting point and good saponification characteristics, to be very easy to clean, and to offer cost savings up to 20 per cent over materials of similar characteristics. Tallow 5B42, of even higher grade, is also more economical than similar tallows. It has higher lubrication and saponification properties than 5B41, and is exceptionally easy to clean. Tallow 5B47, highly saponifiable and giving good lubrication, is most economical in cost. For further information, use Reader Service Card.

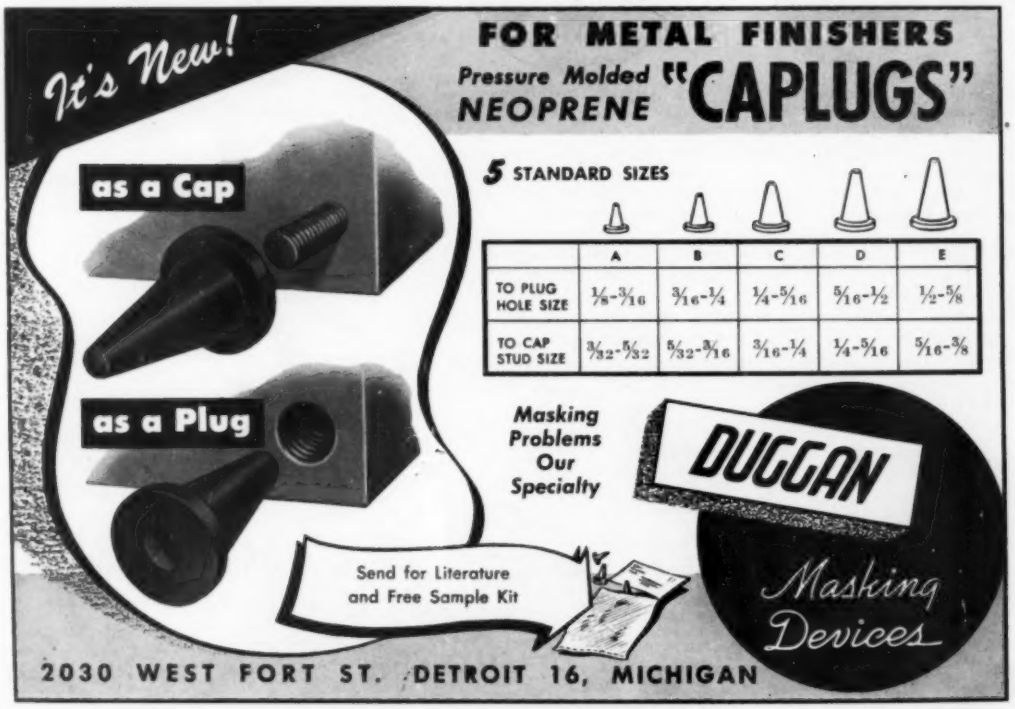
E—695. Solvent Pump—The Tokheim Oil Tank and Pump Company, Fort Wayne, Ind., announces the addition of three new industrial models to its line of High Vacuum Hand Pumps. The new units are approved by Underwriter's Laboratories for dispensing gasoline and petroleum-base products and useful in dispensing many other industrial liquids such as solvents. For further information, use Reader Service Card.

E—696. Black Oxide Process for Steel—The Mitchell-Bradford Chemical Company, 2446 Main St., Stratford, Conn., announces a new black-oxide process for iron and steel known as Black Magic Type A. A one-bath, one-salt process operated at 290° F, it requires only 6½ lb of Black Magic salts per gallon. This results in low initial cost, and low cost of replenishment. The solution is highly fluid, which results in a minimum of drag-out. A type of black iron oxide, Fe_3O_4 which will adsorb a large amount of the final oil or wax coating, provides high corrosion resistance.

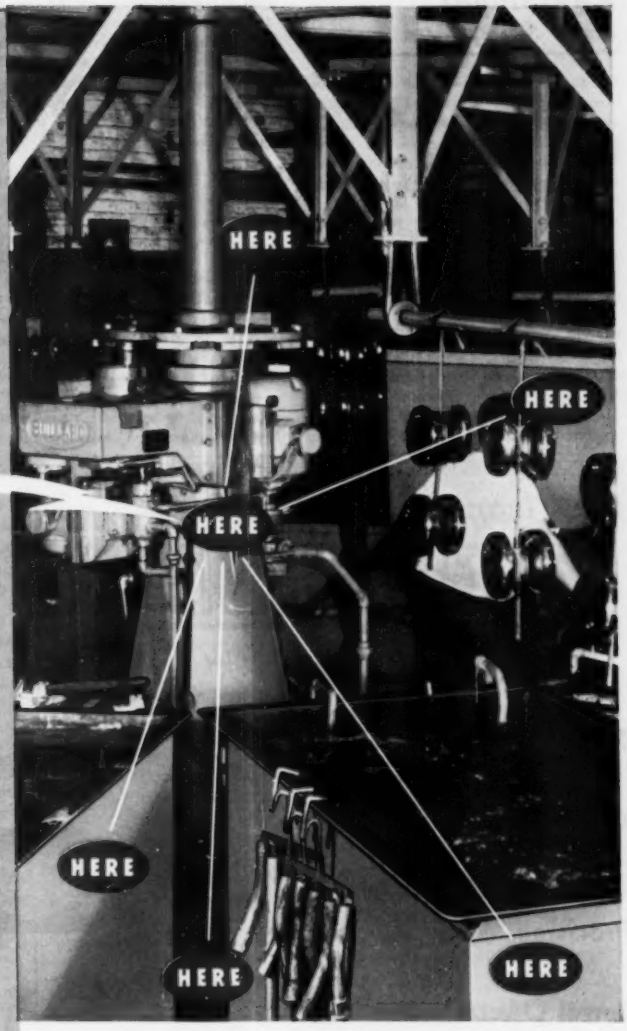
Blackening time cycle is short, and heat-treated or hardened work is easily blackened. The solution rectifies colloidal red iron oxides in the bath and other contaminants, which might inadvertently be introduced. Because of this, steel parts with brazed areas can be processed without difficulties. For further information, use Reader Service Card.

E—697. Air-drying Protective Coating—Development of a new air-drying plastic protective coating, U. S. Royalguard, has been announced by the Mechanical Goods Division of United States Rubber Company. It is used to protect tanks, pipes, fittings, structural-steel parts, and chemical processing equipment against attack by splash, drip and spray from corrosive chemicals, corrosive atmospheres and weathering, and is expected to find its broadest use, among other fields, in chemical processing, sewage disposal, filtering and electroplating.

Combining high and lasting film flexibility with good adhesion and impact



Don't Let Corrosion Strike



Protect with

TYGON
the corrosion-resistant plastic
PAINT

Write for this helpful booklet
Today

Tells how and where you can use Tygon Paint to keep your maintenance costs down . . . your plating room up.

U. S. STONEWARE, Akron 9, Ohio

Your plating room and plating room equipment cost you a lot of money. Don't let it corrode away.

Timely preventative maintenance can extend your plating room life many years. The few extra pennies preventative maintenance costs are peanuts compared to what you save.

To lick corrosion, don't let it get a start. *Inspect, clean,* and *paint* with Tygon. This chemically-resistant plastic paint will hold repaintings to a minimum. But don't expect it to last forever. It won't. *Inspect, clean* and *touch-up* with Tygon. Watch gouges, scratches, worn spots. Patch breaks as they occur.

You can use Tygon on metal, concrete or brick. Apply it by spray gun or brush. It air dries quickly.

Equipment and Supplies

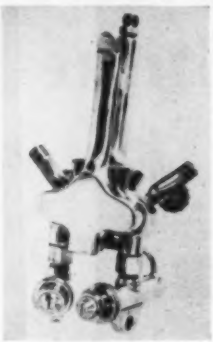
resistance, it can be used directly on steel-grit- or sand-blasted aluminum, hydrochloric acid-etched concrete, roughly sanded hardwood or composition board. It is applied by spraying, allowing one hour drying time between coats and 24 hours drying time after the final coat. A sharp instrument will cut through the film, but the break can be repaired easily by "touching up" with brush or spray. For further information, use Reader Service Card.

E—698. Safety Solvent—FO 128 is the latest solvent in the line of "FO" chemicals marketed by Fine Organics, Inc., Aviation Industrial Chemicals Division, 211 E. 19th St., New York 3, N. Y. It is offered for use as a safe alternative for carbon tetrachloride in applications where toxicity or solvent residues are factors. A clear, water-white solvent with drying time equal to Stoddard solvent, it has a flash point (P-M closed cup) of 140° F, low toxicity, and minimum dermititus effects. For further information, use Reader Service Card.

E—699. Airdry Synthetic Coating—Neoprene can now be applied by brush or spray gun as an airdry protective coating for industrial maintenance work on structural steel, concrete, wood and exterior surfaces of tanks and equipment in a single coat of 5-10 mils thickness. Outstanding properties are said to be resistance to oil, grease and chemicals and to age-cracking by sunlight, weather and ozone; lasting resilience, elasticity, high abrasion resistance.

The coating material is produced by Gates Engineering Company, lining and coating applicators of Wilmington, Del., and has been named Gaco Neoprene Maintenance Coating. It is a solvent solution that will not gel in the container, but will cure at normal temperatures after the solvent has evaporated. Surface preparation need not include sandblasting or use of a primer, according to tests. For further information, use Reader Service Card.

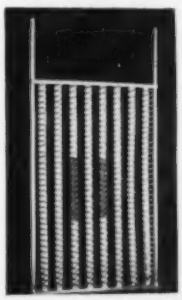
E—700. Polyester Syray Gun—Schori Process Division, Ferro-Co Corporation, 8-11 43rd Rd., Long Island City 1, N. Y., has placed on the market a paint spray gun that sprays two solutions at the same time. The gun was developed to handle



materials that will be tack-free in ten minutes. If these formulations were mixed in a single pot and sprayed through an ordinary spray gun, the material would set in the pot before it could be sprayed.

Marco resin formulations, especially developed for use with the Schori model 28 spray gun, are available from Schori. For further information use Reader Service Card.

E—701. Anodizing Rack—All-Brite Chemical Company, Main St., Oakville, Conn., offers a new type of aluminum rack for use in anodizing aluminum parts. Made of 0.050-inch tempered aluminum,



it is stamped out in one piece and has no rivets, wires, or loose connections. The rack will handle 74 small pieces by itself. With 8 units on a frame, the combined rack can handle up to approximately 600 pieces, as illustrated. For further information, use Reader Service Card.

for Cleaning Processes It's—

PERMAG

There's a PERMAG Compound for ALL Cleaning Jobs — *Below are a few items we draw to your Attention*

Removing Buffing Compounds

PERMAG positively does the trick —quicker—lower in cost—less time.

Cleaning Buffed Zinc Base Die Castings

Here's the test: PERMAG eliminates all film—free rinsing—no discoloration—fast cleaning action.

Precision Work

For cleaning delicate parts—tubes—similar pieces, PERMAG proves most satisfactory.

Barrel Operations

For deburring—roughing—descaling—burnishing. PERMAG is pre-eminently suited for this work.

Cleaning Aluminum

Send for New Booklet—full of information on cleaning, frosting, stripping, burnishing processes.

Cleaning Steel for Final Plate

PERMAG Ferrolyte—removes slushing compounds, drawing compounds, oils, grease, smut. Information Sheet free.

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Manufacturers of Specialized Cleaning Compounds for Industry

50 Court St. BROOKLYN 2, N. Y.

In CANADA: Canadian PERMAG Products, Ltd., Montreal, P.Q.

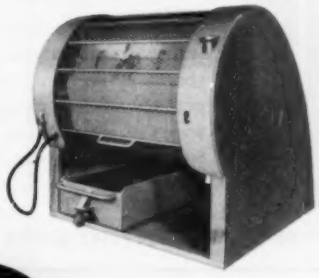
A Statement about Modern Tumbling

De-burring and finishing metal parts by tumbling with chips and compounds in specially designed machinery is a relatively new process. This technique was initially developed just prior to World War II, and was designed primarily for finishing parts preparatory to plating. The effects of chips and compounds on different metal parts were studied through a trial and error effort. Surprisingly good finishes were obtained which could be duplicated uniformly.

Successful grinding and finishing were performed on steel, brass, aluminum, stainless and nickel steels—on castings, forgings, stampings, and machined parts. Uniformity on quantity lots was attained from severe grinding to fine finishing. Likewise, a more uniform surface finish was obtained and dimensions were held to close tolerances. Besides producing a superior finish on most work, the process indicated tremendous savings in direct labor.

Tumbling Aids World War II Production

It was at about this same time that manufacturers became occupied with defense, and, shortly later, war production. Tumbling was a natural answer to the extreme demands put upon producers to step-up de-burring operations. The faster tempo of increased manufacturing could not be satisfied by old fashioned, hand applied methods. Tumbling with chips and compounds broke this bottleneck, because it could do the job not only faster with less labor, but could do it as accurately or more so than by hand. Standardized procedures were established, based on the experience of using certain types and sizes of chips, and various compound preparations on different kinds of metal parts. Savings were made over hand methods by as much as 80% on work for aircraft, electronic, naval, munition, and military vehicle production.



Grav-i-Flo Offers Improved Tumbling

Grav-i-Flo now offers the first big advancement in modern tumbling with new equipment and materials that increase direct labor savings over previous tumbling methods. New Super-Brite chips and specially designed machinery cut both ferrous and non-ferrous metals 25% to 40% faster, handle 30% more work load in the same floor space, eliminate subsequent operations as ball burnishing. New compounds change chip surface from finishing to cutting in minutes, and eliminate need to transfer parts from machine cylinder.

Investigate Grav-i-Flo Now!

By employing the Grav-i-Flo process, manufacturers will achieve even greater savings in de-burring parts for defense items than in the former preparedness program. Those producers handling defense contracts should investigate the possibilities of Grav-i-Flo for their work. The Grav-i-Flo Corporation will process samples free to show how your parts can be deburred at substantial savings! Send samples direct to The Grav-i-Flo Corporation.

TUMBLE GRAV-I-FLO FINISH

THE GRAV-I-FLO CORPORATION

Dept. P-6 400 Norwood Avenue

STURGIS, MICHIGAN

New Improved Service Facilities For STEVENS CUSTOMERS

This modern, well-lighted workroom is Stevens' new experimental polishing and buffing laboratory . . . developed and expanded to serve the needs of metal finishers.

For years the Stevens organization has concentrated on bringing better polishing and buffing methods to users of Stevens compositions. To provide this service, Stevens has maintained facilities for finding quick, practical answers to customers' production problems. Our new installation—featuring all new machines and highly experienced technicians—working with our composition laboratory—enables us to extend this service far above and beyond previous efforts.

Let us help you find new polishing and buffing profits with Stevens methods and materials. Our staff can show you many ways to cut costs *and* improve your finished product—without obligation. Either call on your nearby Stevens representative or write direct to Frederic B. Stevens, Inc., Detroit 16, Michigan.

METAL FINISHING EQUIPMENT AND SUPPLIES SINCE 1883

FREDERIC B. **STEVENS** INCORPORATED

BRANCHES • SALES OFFICES

DETROIT 16, MICHIGAN

plating

JUNE, 1951 VOL. 38, No. 6

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PLATING is abstracted regularly in Chemical Abstracts, Engineering Index, Technical Data Digest and Bulletin Analytique.

Harshaw

cadmium fluoborate plating solution

ADVANTAGES

1. Simple make-up and control
2. High plating speeds
3. Anode and cathode efficiencies approximately 100%
4. Decided reduction of hydrogen embrittlement of hardened steel

SOLUTION COMPOSITION (TYPICAL)

Cadmium Fluoborate	32 oz/gal
Cadmium	12.5 oz/gal
Free Boric Acid	3.0 oz/gal
Ammonium Fluoborate	8.0 oz/gal
Addition Agent	As required

OPERATING CONDITIONS

pH (Colorimetric)	4.0—5.0
Temperature	75°—100° F
Current Density	20—70 AMP./sq.ft.
Agitation	As required (mechanical or air)

BATH MAKE-UP

Bath prepared by dilution of concentrate, containing about 42 oz/gal Cadmium, then adding Ammonium Fluoborate as indicated. The pH is raised with Ammonia Water or lowered with Fluoboric Acid.

EQUIPMENT

Tanks: Rubber lined steel or approved synthetic materials
Barrel Cylinders: Bakelite or hard rubber.

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Editorial

Cheap and Expensive Dollars

AMONG THE CURIOUS EFFECTS of the rearmament program of interest to the plating industry is that many companies now have two kinds of dollars to spend. This was recently pointed out by Beardsley Ruml, noted economist and former chairman of the Federal Reserve Bank of New York, when he drew attention to the "expensive dollars", worth 53 cents after payment of ordinary taxes at the rate of 47 per cent, and to the "cheap dollars", worth only 23 cents after payment of excess-profits taxes at the marginal rate of 77 per cent.

Instead of paying excess-profits taxes, a company should, according to Mr. Ruml, use its cheap dollars to pay such expenses as may not be justified with expensive dollars. Among these expenses are tooling for new markets, reorganization of production flow, salaries of additional executives, testing of old and new products under problematical conditions, extension of branch offices into uncertain areas, increasing advertising for more complete coverage.

Many companies did those very things during the last war and profited by improving their competitive positions. A similar opportunity is offered now, if management can forecast what excess profits would be likely to be and if it will lay plans for the judicious spending of income otherwise subject to excess-profits tax.

Ordinary expenses, paid with expensive dollars, should, of course, be controlled as usual.

Mr. Ruml makes a distinction between legitimate tax avoidance and unlawful tax evasion. The boundary between the two, however, is not always clearly defined. For example, it is sometimes difficult to say when the cost of research is a current expense and when it must come out of profits (be capitalized). At times the right decision can be made only in consultation with an expert tax lawyer.

Gustaf Soderberg

Increased Belt Life and Cut With New Contact Wheel

W. K. VAN ORMER

Coated Products Division, The Carborundum Company, Niagara Falls, N. Y.

A new type of rubber contact wheel for abrasive-belt polishing with backstand idler permits the operator to double the output from a standard abrasive belt in those operations where glazing normally occurs.

The result of more than three years of development and research by Carborundum engineers, the new "61" wheel is a specially serrated rubber wheel (Fig. 1) that causes a controlled breakdown of the bond of the abrasive belt and hence reduction of glazing, long the enemy of prolonged and productive belt life.

Whereas the idea of a serrated rubber contact wheel is not new, the relief angle, the wide spacing and the narrowness of the lands (based largely on the design of milling cutters) are entirely new developments, and are responsible for the increase in belt life and cutting rates.

Regular Polishing

Laboratory Tests

In the grinding laboratory of Carborundum's Coated Products Division, comparative tests were made on a belt backstand grinder of all known types of rubber contact wheels. The same belt type—14-ft x 4-inch No. 80 ALO EC M—was used in each test, on low-carbon SAE 1015T descaled steel, at 7350 surface feet per minute. As shown in Table I, the new wheel permitted the removal of 2 to 4½ times the weight removed with the use of the other wheels. Maximum

TABLE I. BELT PERFORMANCE WITH VARIOUS CONTACT WHEELS

Belts: 14-ft x 4-inch No. 80 ALO EC M paper belts

Belt Speed: 7350 sfpm

Stock: SAE 1015-T descaled hot-rolled steel

Contact Wheel	Rate of Stock Removal, g/min, after								Total Stock Removed g	Belt Life contact-minutes		
	1 min	4 min	12 min	24 min	30 min	40 min	60 min	80 min		max	aver. work	heat-sensitive work
No. 50 Durometer Plain	90	60	34	..	..	..	..	..	724	16	13	10
No. 50 Durometer ½ x 3/8-inch serrations	75	66	42	17	..	..	..	..	1030	24	20	13
No. 70 Durometer ½ x 3/8-inch serrations	80	65	47	24	22	..	..	..	1413	30	24	16
No. 60 Durometer R 52	89	61	44	26	21	..	..	..	1355	34	24	13
No. 60 Durometer R 51	76	53	43	38	30	19	..	..	1571	40	36	22
No. 70 Durometer New "61"	75	66	53	48	50	40	31	25	3221	80	66	38

belt life in terms of minutes of contact before complete glazing was increased from 2 to 5 times. Average belt life was increased from 1.8 to 5 times, and belt life for very heat-sensitive work (thin sections, easily overheated) from 1.7 to 3.8 times. The table shows that whereas initial cutting rates during the first few minutes of operation were as high or higher for belts on the other types of wheels, these high initial rates dropped off sharply. Belts on the new wheel showed a markedly longer over-all belt life and only a slight reduction in cutting rate with time—in fact, an average reduction of only 0.625 g/min over a period of 80 minutes' operation. This great improvement is demonstrated further in Fig. 2, showing spark patterns from belts on an old type and the new type wheel, and in Fig 3, in which the size of chips removed are compared.

Field Test

In a recent test in a customer's plant, the new "61" contact wheel was used in the flat-surface grinding of

Fig. 1. The new "61" contact wheel

auto bumpers prior to forming. Thirty-inch wide belts on Hill-Acme Company wide-belt surface grinders were employed. Previously 300 pieces had been obtained per belt. With the new contact wheel, 600 pieces were obtained, with an increase of 128 per cent in stock removal The percentage of rejects was decreased radically, and a much more consistent finish was realized from the first piece to the last because of the more constant rate of cut. As a result, "61" wheels are now being installed on the production line of this customer.

Other Field Results

On jobs where extremely soft buff-type or compress-canvas contact wheels are now in common use, stock removal and belt life are being doubled or tripled with fine-grit belts in the No. 120–500-grit range employed with "61" wheels of 20 Durometer. These results confirm other laboratory studies. Improved finishes in less time are also noted.

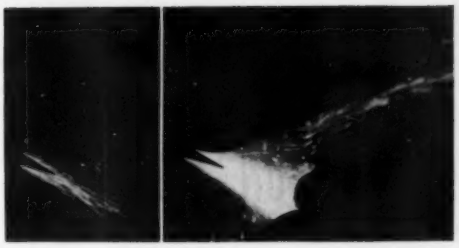

Fig. 2. Spark patterns on belt polishing with, left, a No. 60 Durometer R 51 contact wheel after 24 minutes of operation; right, a "61" contact wheel after 80 minutes of operation. Camera exposure, F5.6 at 1/50 sec. Note difference in lighting effect

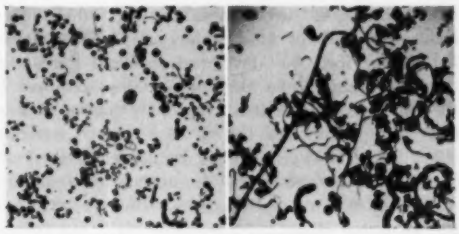

Fig. 3. Chips removed by belt polishing with, left, No. 50 Durometer standard-serration contact wheel after 24 minutes of operation; right, a "61" contact wheel after 80 minutes of operation. Magnification, 13X

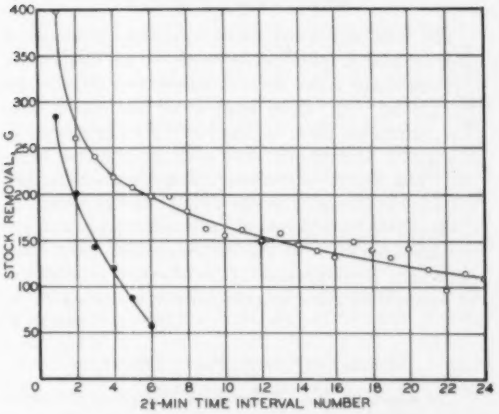

Fig. 4. Stock removal during consecutive 2½-minute intervals by means of a 14-ft x 4-inch 60 ALO M resin industrial cloth belt at 5600 sfpm on ends of hot-rolled SAE 1020 angle iron. Top curve, with No. 70 Durometer "61" contact wheel; bottom curve, with No. 70 Durometer standard-serration contact wheel

(Continued on page 557)

DETERMINATION OF PLATE THICKNESS ON ZINC BASE ALLOY DIECASTINGS

HAROLD E. BROWN

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OF THE SEVERAL METHODS for plate-thickness determination, the microscopic measurement, at high magnification, of the thickness at a specified significant location is perhaps most widely used. The method herein described was developed to avoid the several time-consuming and rather precise steps required by the microscopic method, especially arduous when many samples must be tested. It is used to determine the average thickness on significant surfaces of diecastings. Size and weight limitations of equipment restrict its use to small castings, although large ones can be tested if sectioned to sizes which can be conveniently weighed on an analytical balance. Similarly, pieces can be cut from selected locations, such as recessed or protruding areas, and thickness measured to give information about the distribution of the plated metal.

Chromium Plate Thickness

The total significant plated area of each sample is first calculated from measurements of its dimensions. Nonsignificant areas, such as insides and threads, are blocked off with rubber stoppers or beeswax or both. The chromium plate is dissolved in 20 per cent by vol conc'd hydrochloric acid solution in Pyrex beakers. The weight of chromium is determined by converting the chromic chloride ($CrCl_3$) to chromium trioxide (CrO_3) with perchloric acid and titration of the chromic trioxide with ferrous ammonium sulfate and potassium permanganate. The beeswax coating can be removed by immersing the castings in boiling water.

Nickel and Copper Plate Thickness

The zinc-alloy base is dissolved. Grinding the edges of nonsignificant surfaces to expose the zinc alloy will shorten the time required for solution. However, care should be taken not to expose too large an area of basis metal, because action of the acid may become too violent and cause the copper plate to dissolve.

The castings are dissolved in beakers containing 200 ml of 20 per cent by vol conc'd hydrochloric acid and 3 ml of additional concentrated hydrochloric acid for each gram of alloy. The beakers are placed in a cooling pan with running cold water. After about two hours, the water is turned off and the beakers left in the bath for a total of 24 hours.

The shells of copper and nickel plate are then lifted out of the beakers, and the nonsignificant portions cut or broken off. Each shell is tested for undissolved zinc by immersing it in a solution of 50 per cent by vol conc'd hydrochloric acid. When free of zinc, the shell is thoroughly rinsed, first in running tap water and then in distilled water. After a dip in alcohol, it is dried in an air bath at 100°C (212° F), cooled, and weighed carefully. The weight is the combined weight of nickel and copper plate.

Removal of Copper from Nickel

Two methods may be used to dissolve the copper, namely, the polysulfide-cyanide method and the chromic-sulfuric acid method. Both are very satisfactory, but the polysulfide-cyanide strip seems to act slowly on fine-grained copper. The acid strip, on the other hand, acts the same and more rapidly and positively on all types of copper deposit. The life of the acid strip in terms of dissolved copper is equal to or longer than that of the polysulfide solution.

The polysulfide-cyanide method.—Two solutions are used. The polysulfide solution is made from the following ingredients:

Sodium sulfide	200 g
Sulfur	20 g
Water	1 l

The sodium sulfide is dissolved in about three-fourths of the water and heated to boiling to dissolve the sulfur. The solution is then diluted to volume with water.

The cyanide solution is a 20 per cent solution of sodium cyanide. Both solutions are used at room temperature.

The copper-nickel shell is immersed in the sodium

polysulfide bath until the copper becomes black copper sulfide and begins to peel off the nickel. The sample is then rinsed in water and immersed in the sodium cyanide solution to dissolve the copper sulfide. When only the nickel shell remains, it is removed and rinsed thoroughly in water, dipped in alcohol, dried, and weighed carefully. The weight of the nickel shell deducted from the weight of the copper-nickel shell gives the weight of copper.

Each liter of polysulfide solution should suffice to convert not less than 775 sq in (5,000 sq cm) of copper plate of approximately 0.0005 inch (13 μ) thickness. As its action slows down, the solution may be regenerated by adding a few ml of 50 per cent NaOH solution saturated with sulfur, say 5 ml per liter of polysulfide strip. Addition of sodium cyanide extends the life of the cyanide solution when its solvent action has become reduced. When the addition of cyanide seems to give no improvement, the bath is discarded and a fresh one made up.

The chromic-sulfuric acid method: Only one solution is used, at room temperature:

Chromic acid	500 g/l
Sulfuric acid	50 g/l

When all copper has been dissolved, the remaining nickel shell is thoroughly rinsed in water, dipped in alcohol, dried and weighed as above. The first water rinse is used to maintain the volume of the strip.

Thickness Calculation

Knowing the weights of chromium, copper and nickel and the area of the sample in square inches or square centimeters, one can obtain the average thickness of the separate coatings by using the following formulas:

$$\text{Chromium, inch} = \frac{\text{gram chromium} \times 0.357}{\text{area in sq in}} = \frac{\text{gram chromium} \times 0.0554}{\text{area in sq cm}}$$

$$\text{Copper, inch} = \frac{\text{gram copper} \times 0.284}{\text{area in sq in}} = \frac{\text{gram copper} \times 0.0441}{\text{area in sq cm}}$$

$$\text{Nickel, inch} = \frac{\text{gram nickel} \times 0.289}{\text{area in sq in}} = \frac{\text{gram nickel} \times 0.0448}{\text{area in sq cm}}$$

Discussion

The weighing-dissolving-reweighing methods described here permits batch handling of many samples. It is estimated that two or three operators working together can turn out at least five times the quantity of work that the same number of people can do by microscopic measurement or by chemical analysis. If many samples of the same item (area) are tested, the area may be included in the factors to speed calculations. For example, weight of copper times the copper "article factor" will give the thickness of copper directly.

The accuracy obtained is as good as or better than the accuracy of either microscopic or straight chemical procedures. A sensitive balance for accurate weighing (sensitivity 1/10 mg) and accurately calculated areas assure results with a low percentage of error.

Determinations of cyanide-copper plate thickness usually check those made by the microscopic method, probably because of the excellent throwing power of this bath. Nickel plate thickness values are generally higher, to an extent depending on the contour of the plated article.

Acknowledgment

The basic information on polysulfide stripping was obtained from the report by Dr. F. C. Mathers on Research Project No. 1, "Stripping of Copper from Various Base Metals", published in Volume 33 of the *Proceedings* of The American Electroplaters' Society (1946).

Belt Life

(Continued from page 555)

Rough Snagging

In these foregoing operations, belts are discarded due to glazing. In operations where the abrasive coating on the belts wears down completely—such as in extremely rough snagging—resin-bonded abrasive belts on the new wheel indicate a similar improvement. This is shown in Fig. 4, in which the ends of hot-rolled SAE 1020 angle irons were ground on 14-inch diameter, 4-inch wide 60-grit resin industrial cloth belts with No. 70 Durometer rubber contact wheels with standard and with new-type serrations. With the former, the total stock removed was 4169 g during 1 hour of total contact time; with the latter, only 896 g during the short life of the belt of 15 minutes' total contact time.

Additional Advantages

In addition to producing longer belt life, higher stock-removal rates, and a more uniform finish, the new wheel reduces the number of belt changes. Moreover, because it assumes a large part of the work, operator fatigue is reduced effectively.

New applications for abrasive belts, never before considered economically practical, now come within the range of possibility.

SAMPLING AND FLOW MEASUREMENT OF WASTE WATER

WATER SHORTAGES of the last few years in certain localities, prospective materials shortages, and the passage of "clean stream" laws have made many plants conscious of the need for consistent sampling of waste waters and measurement of their flow. With a definite knowledge of the composition and volume, it is often possible to treat waste water for reuse in the plant or so that it will be acceptable for admission to streams or municipal sewers. In certain cases, the study of waste waters has permitted the recovery or conservation of valuable raw materials, which otherwise might have gone down the drain.

Many improvised sampling systems have worked well. As the problem has been more fully understood, however, there has been a growing demand for completely automatic systems.

Five such systems are shown here. They afford a choice between intermittent and continuous sampling, from lines flowing under pressure or from open channels.

In each case a Hagan Ring Balance Meter is used to indicate, integrate and record flow, as well as to actuate the sampling mechanism. The applications were worked out through cooperation between engineers of Hagan Corporation and Hall Laboratories, Inc., water consultants.

Intermittent Sampling

The intermittent sampling systems are shown in Figs. 1 and 2. The Ring Balance Meter is equipped with a device which generates electrical impulses proportional to the flow. These impulses are fed into a counter, which adds them to some desired value, after which the counter makes a contact on a timing relay.

For intermittent sampling from a line flowing under pressure, Fig. 1, the timing relay opens the solenoid valve in the sampling line from the main flow line for a given time for flushing and then admits the required sample to the sampling chamber. The valve is positioned to "flush" or "sample". The system then shuts down until another predetermined quantity of fluid passes, and the cycle is repeated.

For intermittent sampling from an open channel, Fig. 2, the arrangement is approximately the same. A pump is used instead of the solenoid-operated valve. The primary element at the meter uses a single dip tube and bubbler system in place of the orifice in the line under pressure.

Continuous Sampling

For continuous sampling from a line flowing under pressure, Fig. 3, a Ring Balance Meter is used with transmitter which transmits a pneumatic signal which is linear with flow. This air signal then positions a diaphragm control valve to admit to the container a sample proportional to the flow.

Continuous sampling from an open channel can be achieved with the arrangement in Fig. 4. The pneumatic signal, operating through a pneumatic controller, adjusts the output of a pump which delivers a sample proportional to flow. The dip tube and bubbler system is similar to that illustrated in Fig. 2.

An adaptation of Fig. 4, in which an electric control (such as the General Electric Thymotrol or the Westinghouse Mototrol) is used to govern the operation of the sampling pump, is shown in Fig. 5.

Additional information concerning sampling and

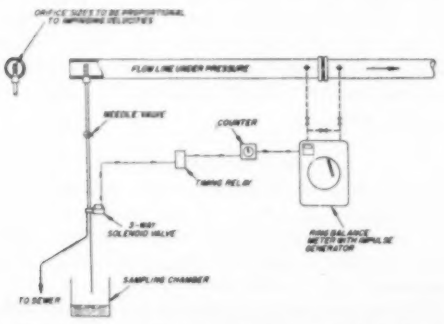

Fig. 1. Intermittent sampling of water from line under pressure

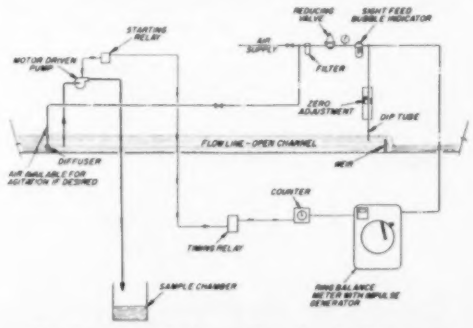

Fig. 2. Intermittent sampling of water from open channel

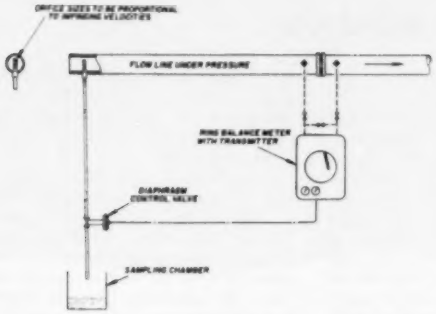

Fig. 3. Continuous sampling of water from line under pressure

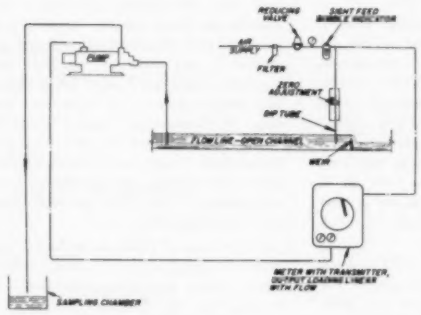

Fig. 4. Continuous sampling of water from open channel

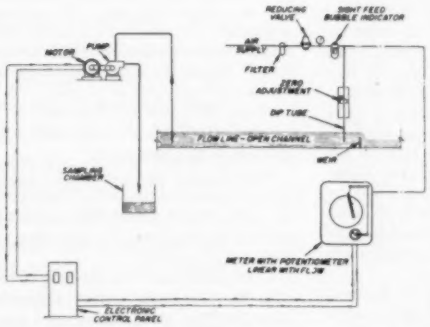

Fig. 5. Variant of continuous sampling of water from open channel

gaging methods are referred to the discussion of "Gaging and Sampling Water-Borne Wastes" by Charles F. Hauck in the A. S. T. M. Bulletin of December, 1949*.

*Reprints may be had on request to the Hagan Corporation, Hagan Building, Pittsburgh 22, Pa.

Book Review

DR. HAROLD J. READ

Associate Professor of Metallurgy, Pennsylvania State College

ELECTROPLATING by A. H. Saunders, 1950, vii + 118 pages. International Textbook Company, Scranton, Pa. Price, $2.75.

This little book has proven to be far more difficult to review than to read. It is obviously of no interest to the skilled practical plater with even a modest theoretical background. The question which arises is this: will the material which has been presented so tersely be at all intelligible to a tyro in the science and art of electroplating? Ninety-three pages of actual text is a very short space in which to set forth not only the basic theory and laws on which electroplating depends but also the entire field of technical practice, including power supplies and plating equipment in general—with nine pages of special instructions to hobbyists to top off everything else. The reviewer has finally concluded that the book may have some merit as a refresher course for the individual who has more than a passing acquaintance with electroplating and who does not wish to read a more pretentious text, but that it is inadequate as a book of instruction for the beginner. It might serve the latter purpose if it were used in conjunction with a series of lectures where many of the topics would be discussed in greater detail.

The brevity of the text is not counterbalanced by brilliant writing, in fact, it is rather on the dull side, and the meaning is obscure in many places. One finds, for example, on page 40 a statement that ". . . good results are achieved . . . if the maximum ratio of chromic acid to total catalyst acid radical . . .". One supposes that the author meant *optimum* ratio, but would an uninitiated reader be aware of this? In several places there are errors of fact, such as the remark on page 47 that pure zinc dust is employed in the sherardizing operation. Even more serious, however, are several over-simplified discussions such as the page or two on the theory of alloy plating. It is difficult to see how this could be intelligible to anyone who was not already quite familiar with the matter. Nowhere are the author's difficulties with lucid exposition more evident than in the glossary, where the definitions are often more confusing than enlightening.

So much fault having been found, it is only fair to point out that the recommendations for practical plating operations are eminently sound, and the formulae for solutions represent good modern practice. The author has exercised excellent judgment in the selection of baths and processes, and has included only those which have proven successful in industrial use.

Washington Orders

Copies of NPA orders and publications may be obtained from National Production Authority, Washington 25, D.C., or from any of its local offices.

Artificial graphite and carbon.—Details of a proposed order were discussed at a meeting of the Artificial Graphite Producers Industry Advisory Committee with NPA on April 27. It is proposed to require filing of applications with NPA for allotment by the 10th of the month preceding the quarter in which the material is needed, to require monthly reports by producers, shippers and consumers of any product covered by the order, and to establish inventory limitations on certain products. Most material of this kind is now being absorbed by DO-97 rated orders (MRO).

Cadmium.—Order M-19 was amended on April 26 to permit plating of additional fasteners for aircraft, namely, all ferrous screws and other threaded parts, hi-shear rivets, lock bolts and collar pins; parts of automotive and aircraft fuel pumps which come in contact with fuel; and aircraft-battery hold-down bars.

Certifications are no longer required for delivery of finished subassemblies ready for assembly by purchaser into final end-product.

Chemicals.—NPA is making a survey of the production capacity of the chemical industry, its raw-material requirement, and end-use of chemicals. Among those surveyed are sodium bichromates, hydrochloric acid, zinc chloride, carbon tetrachloride, hydrogen peroxide, styrene, vinyl acetate, and ethyl and butyl alcohols.

According to Regulation 4 as amended on April 16, DO-97 ratings may no longer be applied or extended under NPA Regulation 4 to (1) "basic organic or inorganic chemicals, their intermediates and derivatives other than compounded end-products not customarily sold as chemicals", (5) "paint, lacquer and varnish", among others.

Several chemicals, among them carbon tetrachloride and perchlorethylene, on May 1, were placed in Schedule A of Order M-32. No producer need accept a DO-rated order for these products which is received by him less than 15 days prior to the first day of the month in which shipment is requested. For a distributor this "lead time" is 20 days.

The severe world-wide shortage of *sulfuric acid* caused by increased demand by the growing chemical industries and lack of sufficient new sources of elemental sulfur has finally led to the issuance of an NPA allocation order, Schedule 3 to M-45. Sulfuric acid is listed as an Appendix B material, i. e., one for which the purchaser does not apply to NPA for allocation but certifies to his suppliers the end-use to which it is to be put, for example, "iron and steel (pickling)" or "nonferrous metal (pickling)". Specific authorization by NPA on Form NPAF-47 to deliver or use any sulfuric acid is required only in the States of Washington, Oregon, California, Arizona, New Mexico, Nevada, Utah, Colorado, Wyoming, Idaho and Montana, where the shortage is particularly serious. Suppliers in all other States must nevertheless fill applications with NPA on Form NPAF-47 and may not deliver sulfuric acid to a purchaser who has not filed a certified statement of proposed use as required by Order M-45. The filing date is the 10th of the month before the proposed delivery month, and the allocation period is the calendar month.

The small-order exemption without use certificate is 60 net tons of 100 per cent H_2SO_4 per (legal) person per month, which covers most electroplaters. Orders should carry the note "exempt small order".

Copper.—Shortage of copper scrap has forced brass mills to increase the consumption of other materials from 60 to 70 per cent. Copper inventories in that industry have declined sharply, as much as 60 per cent in some cases.

Lead.—According to an NPA release of May 2, the U. S. is getting lead at the rate of 200,000 tons less than last year. Annual consumption is somewhat over 1 million tons.

Rubber.—Order M-2, as amended on May 1, increased the total amount of rubber made available for civilian uses to 100 per cent of that used in the adjusted base period. However, the use of rubber in tires and tubes and in many other items is kept at 90 per cent, making more rubber available for certain vital needs.

Tin.—Evaporated-milk canners, at a meeting with NPA officials on April 12, complained that most electro tin plate was too nonuniform for use by their industry. However, ¾-lb tin plate made by Bethlehem Steel Corporation in its Sparrows Point, Md., plant is acceptable, and the process used there will be made available to the tin-plate industry.

An amended Direction 1 to M-25, Cans, reduces the number of methods for automatic adjustment of base period to one.

Zinc.—The Zinc Dust Industry Advisory Committee was urged to try to develop methods for increasing its production at a meeting with NPA on April 13, for example, through recovery and use of zinc scrap. Committee members suggested that some less essential uses of zinc be eliminated, and that a determination be made of the relative essentiality of zinc dross now largely used in the manufacture of the dust.

Appeals.—A 3-man appeals board was established on April 25 to hear appeals from denials of applications for adjustment of or exceptions from NPA orders and regulations by NPA industry divisions. Regulation 5 sets forth the rules governing appeals.

Compliance.—Federal Trade Commission investigators are assisting the NPA in surveying the industry for compliance with NPA orders and regulations. Noncompliance had been uncovered in 648 cases by April 11, most of them in the areas of construction-inventory control and priorities rules. The tin order M-8, the copper order M-12, and the cadmium order M-19 were disobeyed in one case each; the zinc-use order M-15 in 18 cases.

Controlled Materials Plan.—Beginning with the 3rd quarter, effective July 1, defense and some defense-supporting production and construction will be programmed and essential materials made available for them, using steel, copper and aluminum for the balancing operation. WPB experience during World War II has showed that if NPA can make these three "controlled materials" available for a program, it can usually insure availability of the other materials necessary to go with them.

In the case of Class A products, which include special-purpose items, such as tanks, planes and ships, allotments will be made by the claimant-agency (Army, Air Forces, Navy, etc.) to its prime contractors, who in turn will make allotments to their subcontractors for such A items that they will furnish. Manufacturers of A products will be assigned DO ratings to obtain Class B products, i. e., common industrial components such as bearings, fractional horsepower motors and many tools. Allotments of controlled materials for the manufacture of B items will be made by NPA industry divisions.

Origin of all allotments is the NPA Requirements Committee.

It is expected that considerable quantities of "controlled materials" will be left for civilian use. Their distribution will be made through materials (M) orders and limitation (L) orders.

CMP Regulation 1, dated May 3, contains the basic rules for the Controlled Materials Plan. It is accompanied by an Official CMP Class B Product List. CMP Regulation 2, not issued at this writing, will be the inventory regulation. CMP Regulation 3, dated May 3, covers priorities and how industry will pass from straight priorities to a combination of CMP allotments and priorities. CMP Regulations 4, 5, 6 and 7, not yet issued, will deal respectively with controlled-materials warehouses; maintenance, repair and operating supplies; construction; and repair shops.

An outline of principles and procedures are found in a booklet, "ABC's of CMP".

Disposal of Plating Room Wastes

III. CYANIDE WASTES: TREATMENT WITH HYPOCHLORITES AND REMOVAL OF CYANATES

project no. 10

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Introduction

This paper constitutes the first part of an experimental investigation of methods for disposal of electroplating wastes containing cyanides. The investigation is being sponsored by the American Electroplaters' Society for the purpose of providing the electroplating industry with unbiased information on methods of treating its wastes, so as to avoid pollution of surface and ground waters and deleterious effects on sewer lines and sewage disposal plants.

As a result of a critical review of the literature[9] on the subject of cyanide wastes, it was decided to undertake experimental work on three treatment processes that appeared to be the most promising, namely, (1) oxidation of cyanide ion by means of hypochlorite ion, (2) formation of complex iron cyanides by treatment with iron salts and an alkali, and (3) volatilization of gaseous hydrogen cyanide, HCN, from the solutions. This paper is confined to the method of oxidation by hypochlorite ion, which is the best known and most widely practiced of all methods for treating cyanide wastes. The process is conveniently divided into two steps: (1) oxidation of cyanide ion to cyanate ion and (2) further oxidation to convert cyanate to other carbon and nitrogen compounds (or free nitrogen, N_2, gas). Since cyanate is far less toxic than cyanide, the first-stage oxidation may be sufficient, but this is a still undecided point, some States requiring removal of cyanate as well. Consequently our investigation has included a study of both steps.

Because the actual oxidizing agent in the hypochlorite process is the ion, ClO^-, various materials may be used to supply this reagent. For example, one may start with liquid chlorine, dissolve it in water, and use this solution as the treating agent. Alternately, one may vaporize the chlorine and absorb it in caustic soda solution to form sodium hypochlorite, most of which will be ionized in the solution. One may purchase a sodium hypochlorite solution for use as the treating agent, or one may purchase various grades of calcium hypochlorite (also known as bleaching powder, HTH, Pittchlor, and by other trade names), which can be added directly as the solid, or which can be converted to the sodium salt or used as a slurry in water. All these are merely variants of the process which we have chosen to designate the "hypochlorite oxidation process". Alternative and equally satisfactory designations are "chlorination process" and "chlorine oxidation process".

A great deal of information about this process is already available from different sources, and the purpose of this research has been to check and co-ordinate this information and resolve disagreements where they exist. Acid hydrolysis of cyanates was investigated as a sideline of this research because it appeared to offer a simple and economical means of eliminating them.

TABLE I. RESULTS OF CHLORINATION TREATMENT OF 250-GALLON QUANTITIES OF DILUTE SYNTHETIC SOLUTIONS OF COMPLEX METALLIC CYANIDES[12]

	Solution Treated		
	Sodium Zinc Cyanide	Sodium Cadmium Cyanide	Sodium Cupro-Cyanide
Concentration of cyanide, ppm CN			
Untreated solution	83.8	85.6	74.2
Treated solution	0.1	0.1	0.1
Toxic metal in treated solution after neutralization, ppm	2 (Zn)	0.03 (Cd)	0.05 (Cu)
Caustic soda added, lb NaOH/lb CN	2.28	2.38	4.77
Bleaching powder added, lb available Cl_2/lb CN	3.03	3.03	3.30
Sodium thiosulfate used, lb $Na_2S_2O_3 \cdot 5H_2O$/lb CN	0.2	0.2	0.3
Bleaching powder used, lb available Cl_2/lb CN	3.00	3.00	3.26

All of the experimental work was done on a laboratory batch scale, first with synthetically prepared and then with actual electroplating solutions in diluted or concentrated form. No attempt has been made so far to study the engineering and economic aspects but only the chemical factors involved. It is hoped to compare, at the end of this experimental program, the different methods of treatment on an engineering and economic basis for the purpose of making comparisons of capital as well as operating costs.

Review of Previous Work

The oxidation of cyanides by hypochlorites at first to cyanates and ultimately to carbon dioxide and nitrogen has been known for quite some time, but only in the last ten years has it been studied and applied industrially in the United States. Considerable information about the disposal of cyanide waste by this method was covered by Dodge and Reams[9] in their critical review of the literature through the year 1948, and hence we shall limit ourselves to supplementing that review with later information and to citing some of the more important facts.

A study of the above-mentioned article shows a disagreement between researchers on necessary quantities of reagents to be used, either for oxidation of cyanides to cyanates or for oxidation beyond this stage, and a lack of experimental data on the use of calcium and sodium hypochlorite. Furthermore, there is very little information on the effect of *p*H, the statement being usually made that the *p*H value of the solution to be treated should be at all times higher than 8.5 to avoid formation of cyanogen chloride and perhaps nitrogen trichloride. The former is highly toxic, especially when dissolved in liquid solutions, and the latter, beside being highly explosive, is irritating to the eyes and nasal passages.

I. *Formation of cyanogen chloride*

Extensive information about the formation of cyanogen chloride is given by Price and co-workers[14] and by Allen and co-workers[1]. In the first step of the destruction of cyanides, i. e., in the oxidation of cyanides to cyanates, the following reactions are believed to occur:

$$CN^- + HOCl = CNCl + OH^- \quad (1)$$

$$CNCl + 2OH^- = CNO^- + Cl^- + H_2O \quad (2)$$

Reaction 2 is very slow below a *p*H value of 8.0[1,14], and its rate increases with increasing alkalinity. At a *p*H value of 10, the cyanate formation is very rapid.

Cyanogen chloride is stated to be very toxic. The threshold of toxicity for rainbow trout is about 0.08 ppm of $CNCl$[1] at 17–22° C with water containing 72–87 per cent of the saturation value of dissolved oxygen. From these data it would appear that cyanogen chloride is probably as toxic as cyanide in liquid solutions. The range of threshold toxicity of cyanide has been reported by different investigators as being 0.05–0.12 ppm of CN. These data were obtained under different conditions, nevertheless they give an approximate means of comparing threshold toxicities of the cyanide ion and cyanogen chloride. Cyanogen chloride is more soluble in water than chlorine but can be removed by extensive aeration. It reacts very slowly with the stoichiometric amount of sodium thiosulfate at a *p*H value of about 7, but it can be destroyed by a very large excess of thiosulfate in less than five minutes[1]. According to Price *et al.*[14] cyanogen chloride is also destroyed by excess hypochlorite in a reasonable length of time at a *p*H of 8 following this reaction:

$$2CNCl + 3HOCl + H_2O = 5HCl + 2CO_2 + N_2 \quad (3)$$

With a solution containing 20.3 ppm of CN, buffered at a *p*H value of 7.09 by a monobasic phosphate-sodium hydroxide solution, and with a molar ratio of available chlorine to cyanogen chloride of 2.12 to 1, the reaction was nearly complete in 10 minutes. In this particular case, however, the removal of cyanogen chloride was found to be more rapid than expected for the observed hydroxyl ion concentration, suggesting perhaps that the monobasic phosphate ion accelerated the decomposition.

II. *Formation of nitrogen trichloride*

There is very little information about the possibility of producing NCl_3 by oxidation of cyanides or cyanates or both with hypochlorites, and what information there is, is purely qualitative and not backed up by qualitative data[8]. However, there is more information about the possibility of producing nitrogen trichloride by reacting ammonia with hypochlorites. It is well known that cyanates are hydrolyzed to ammonia, and it is conceivable that during the oxidation of cyanate some ammonia may be produced. If one assumes that the nitrogen in the cyanate radical is oxidized similarly to the nitrogen in the ammonia radical, the following information may be of interest:

a. Dowell and Bray[10] state that the reaction between ammonia and chlorine in a strongly acid solution yields nitrogen trichloride, whereas the same reaction in a strongly basic solution yields nitrogen.
b. According to Prescott and Johnson[13] "a warm solution of calcium hypochlorite treated with ammonia yields nitrogen".
c. According to Chapin[3], in the reaction between the hypochlorite ion and ammonia, NCl_3 is formed if the *p*H of the solution is smaller than 4.4; $NHCl_2$ is produced between *p*H 4.5 and 5.0; and only NH_2Cl is obtained if the *p*H is greater than 8.5. This chloramine is decomposed by alkalies into ammonia and nitrogen[17].

Finally it should be added that Dobrovolny *et al.*[7] did not find any evidence of nitrogen trichloride formation while treating different types of cyanide solutions with bleaching powder.

III. *Removal of cyanide from plating wastes*

There is a general agreement that the oxidation of cyanides to cyanates by hypochlorites is very rapid and that the further oxidation of cyanates to carbon dioxide and nitrogen may require anywhere from a half-hour[8] to more than one day[5]. The presence of metals in plating wastes

should not have any effect on the complete oxidation of cyanides. If the reaction between cyanates and hypochlorites takes place at an alkaline *p*H, it can be expressed by the following equation:

$$2CNO^- + 3OCl^- + H_2O = 2CO_2 + N_2 + 3Cl^- + 2OH^- \quad (4)$$

and equations 1, 2 and 4 can be used to illustrate the fundamental reactions of cyanides with hypochlorites which cause the former to be completely destroyed by a series of three consecutive reactions. The metals are precipitated as carbonates, oxides, or hydroxides. Metallic carbonates are formed upon complete destruction of cyanide or if cyanides are oxidized to cyanates in the presence of carbonate ions. The reagent requirements are the same as in the absence of metallic ions, except when the metal ions themselves are oxidized, as in the case of the cuprous and nickelous ions.

In a recent paper on the disposal of plating shop effluents, Pettet[12] discusses chlorination of cyanides in alkaline solutions, presumably to the cyanate stage. He also mentions that the intermediate product of the reaction between cyanides and hypochlorites is CNCl, which is rapidly destroyed at sufficiently alkaline *p*H values. Some of his results are shown in Table I. The solutions shown in this table were first made alkaline to a *p*H value of 11.0, and then bleaching powder containing 36 per cent available chlorine* was added. Sodium thiosulfate was used to eliminate the excess chlorine after oxidation.

In a written discussion following the presentation of Pettet's paper it was remarked that in cyanide solutions containing nickel the chlorination treatment had not eliminated the cyanide completely.

Treatment of cyanide solutions with bleaching powder was investigated by the Electrochemicals Department of the du Pont Company[6]. The solutions studied were pure alkali-metal cyanide, sodium cuprocyanide, and sodium zinc cyanide. The cyanide content was varied from 10.6 to 55,700 ppm. The *p*H values of the solutions were not reported. The amount of metal left in solution after treatment was determined; for copper it varied between 2 and 6 ppm, for zinc it was constant at 5 ppm. The following conclusions were reached:

a. On the basis that the chlorine availability of the bleaching powder used was 38.2 per cent, 3.64 parts of available Cl_2 were required per part of CN for conversion to cyanate in very dilute solutions (20 ppm NaCN) and approximately double that quantity in strong solutions (100,000 ppm NaCN). However, in the latter case the heat of reaction was enough to convert 99 per cent of NaCNO into Na_2CO_3. No cyanogen chloride was detected by smell, whether sodium hydroxide was added to the solution or not.
b. By boiling a 1 per cent NaCNO solution for one hour, it was possible to convert 78.2 per cent of the cyanate to carbonate.
c. The addition of bleaching powder to a strong sodium cuprocyanide solution caused the copper to be precipitated as bluish basic copper carbonate, whereas from a weak solution the copper precipitated as black cupric oxide.
d. After oxidation of cyanide to cyanate in a sodium zinc cyanide solution, zinc could be precipitated either as basic zinc carbonate by addition of sodium bicarbonate to react with the caustic soda present or as a hydroxide by dilution of the solution with consequent hydrolysis of zincate ion.
e. Sodium cyanate and sodium ferricyanide acted as buffers, retarding the oxidation of cyanide to cyanate.
f. It was possible to decompose 30–45 per cent of the sodium cyanide in a solution containing up to 5 g/l of NaCN (2650 ppm CN) by boiling for one hour, the weaker solutions showing the highest percentage of decomposition.

All of these experiments were done on a laboratory scale. In another report by the Electrochemicals Department of the du Pont Company[7] it was mentioned that the *p*H of cyanide solutions being treated with bleaching powder should never drop below 11.5 in order that formation of nitrogen trichloride and cyanogen chloride be avoided. Also, sodium cyanide and sodium cupro-cyanide solutions of various concentrations were treated with bleaching powder. The concentration of the former varied between 530 and 37,200 ppm of CN and that of the latter between 26,500 and 53,000 ppm of CN. The *p*H value of the solutions was varied between 11.3 and 12.5. No mention was made of the amount of bleaching powder used. The temperature rise during treatment of alkali-metal cyanide solutions varied between 0.5 and 85° C (1 and 153° F) depending on the concentration of cyanide, and the sodium cupro-cyanide solutions showed a constant temperature rise of 82° C (148° F), primarily due to the high and substantially constant concentration. The amount of sludge formed varied between 2 and 100 per cent of the final volume of the treated solution. Appreciable foaming was evidenced for solutions containing more than 16,000 ppm of CN.

A description of the treatment of potassium cyanide solutions with chlorine and sodium hydroxide is reported by Dobson[8]. He found that the oxidation of cyanide to cyanate was practically instantaneous and required 2.73 parts of chlorine per part of CN and 3.08 parts of sodium hydroxide per part of CN. He furthermore reported that "in all trade wastes and laboratory samples tested, no cyanide within the limits of titration accuracy had been found in the presence of available chlorine at a *p*H of 8.5". Another significant point is that in a KCN solution containing 50 ppm of CN, buffered to a *p*H of 8.5, when enough chlorine was added to convert theoretically 58 per cent of the cyanide to cyanate, 58 per cent of the cyanide disappeared but only 49 per cent of the cyanide appeared as cyanate.

This merely means that as soon as some cyanate is formed it starts to react with the hypochlorite ion, and the two reactions are then competing for chlorine. The relative amounts of available chlorine used in the two reactions depend on the reaction rates, which in turn will vary with the conditions. Usually the second reaction in this series of two is so much slower than the first that conversion of cyanide to cyanate is almost quantitative.

In the complete oxidation of cyanides, i. e., beyond the cyanate stage, Dobson found (1) that the reaction required at least one-half hour but less than one hour at a *p*H of 8.5 obtained by buffering the solution with a sodium hydroxide-boric acid buffer, and (2) that the reagent requirements were 7.35 parts of chlorine per part of cyanide instead of the theoretical 6.82 and presumably a proportionate or somewhat smaller amount of sodium hydroxide than that indicated by equation 5. He attributed this increase in chlorine

*Available chlorine may be defined as the chlorine equivalent of the OCl radical present in hypochlorite. On the basis of the following reactions for the formation of hypochlorites:

$$Cl_2 + 2NaOH = NaOCl + NaCl + H_2O \quad (5)$$

$$2Cl_2 + 2Ca(OH)_2 = Ca(OCl)_2 + CaCl_2 + 2H_2O \quad (6)$$

one mole of Cl_2 is equivalent to 1 mole of pure sodium hypochlorite, whereas 2 moles of chlorine are equivalent to 1 mole of pure calcium hypochlorite. Therefore a solution containing 15 per cent by weight of NaOCl would contain $15 \times \frac{70.91}{74.45} = 14.31$ per cent available chlorine, and 1 lb of pure $Ca(OCl)_2$ with a molecular weight of 142.99 would contain $\frac{141.82 \times 100}{142.99} = 99.19$ per cent available chlorine.

TABLE II. REMOVAL OF CYANIDE FROM 100-LITER BATCHES OF DILUTED SYNTHETIC PLATING SOLUTIONS BY CHLORINATION IN THE PRESENCE OF ALKALI

	Experiment No.				
	1	2	3	4	5
	Nature of Solution				
	Zinc Plating	Cadmium Plating	Copper Plating†	Zinc Plating	Cadmium Plating
Initial concentration of ferrocyanide, ppm CN	.....	.....	.....	10.6	11.55
Initial concentration of other cyanides, ppm CN	95.3	109	92.5	85.7	102
Initial *p*H value	9.88	8.75	8.36	10.24	9.30
Weight of slaked lime added, g	11	35	32.5	10	25
*p*H value after addition of lime	11.0	11.24	11.0	11.34	11.02
Weight of available chlorine▲ added, g	27.9	28.2	30.7	23.2	28.3
Concentration of residual cyanide, ppm CN	0.1	0.1	0.1	0.1	0.1
Concentration of residual chlorine, ppm	17	6.4	17	9.4	11
Chlorine absorbed, % of quantity theoretically required	101	93	111*	96	98
Weight of sodium thiosulfate used for dechlorination, g	2	0.6	1.55	1.0	1.2
Volume of sludge settled in 16 hours, % by vol	1.0	1.1	0.9	1.1	0.7
*p*H value after neutralization with carbon dioxide	7.28	7.38	6.76	.....	.....
Toxic metals in solution, ppm	0.75 (Zn)	.....	0.1 (Cu)‡	.....	.....
Temperature, ° C	15.7	12.7	15.5	.....	.....
Effect of settled treated solutions to fish					
Number of fish (rainbow trout) immersed in 40 liters	6	6	6	.....	.....
Number of fish which survived immersion for 3½ hours	6	6	6	.....	.....
Number of fish which survived immersion for 24 hours	6	4	6	.....	.....

*98% if the chlorine demand of the copper is taken into account.
†Copper content of the solution was 60 ppm.
‡Filtered before neutralization.
▲Bleaching powder used probably contained not more than 35% available chlorine.

demand to the possible oxidation of nitrogen with the formation of nitrous oxide or perhaps higher oxides of nitrogen*.

IV. *Acid hydrolysis of cyanates*

It is a well known fact that many nitrogenous compounds, cyanates belonging to this category, can be rapidly converted to ammonium salts by hydrolysis with a mineral acid. The following equation can be used to represent the reaction between an alkali cyanate and sulfuric acid:

$$2NaCNO + H_2SO_4 + 4H_2O = (NH_4)_2SO_4 + 2NaHCO_3 \quad (7)$$

The rate of reaction can be increased by lowering the *p*H value of the solution and by raising the temperature.

There are some references in the literature to the possibility of using this method of treatment following oxidation of the cyanides to cyanates, but no reference has been found to actual industrial application.

The situation as it existed at the start of this research may be summarized as follows:

1. Most of the information available in the literature dealt with commercial treatment of cyanides by hypochlorites, and often this information was inadequate to determine the best operating conditions. Besides, even for treatment done in a given plant, there were large variations of ratio of reagents to reactants, of *p*H values, and of final concentration of cyanide in the treated sludge. In some cases it was not clear whether the reaction had been carried to the cyanate stage or beyond, and the time of reaction was not mentioned, although there were indications that the oxidation of cyanide to cyanate was practically instantaneous, and that further oxidation of the cyanate could require anywhere from one hour to several days. It should also be added that even more detailed information of this kind would not have been too useful to the understanding of the chemical nature of this process, because of the presence of such foreign ingredients as wetting agents, reducing agents, and other unknown substances in the cyanide waste solutions.

2. Most of the work on synthetic (as distinct from actual or commercial) solutions had been done with pure alkali-metal cyanide solutions rather than with electroplating solutions. The reported data, however, although at times inadequate to support final conclusions, presented quantitative results which could be interpreted to give information about the ratio of reagents to reactants as follows:

a. For oxidation of cyanide to cyanate, about 2.8–3.6 parts of chlorine per part of cyanide were required. For solutions containing cuprous ion the chlorine re-

*Since the foregoing was written more information was found in the literature [Eden, G. E., Hampson, B. L. and Wheatland, A. B., J. Soc. Chem. Ind. (London) 69, 244–249 (1950)] on the possible formation of oxides of nitrogen as a result of the reaction between hypochlorites and cyanates. In the treatment of a cyanide solution (containing 96.3 ppm of CN) with 7.62 parts of available chlorine per part of CN, it was found that about 11–12 per cent of the nitrogen originally present in the cyanide radical had been converted to nitrate, and that the amount of hypochlorite used in excess of the stoichiometric requirements for the oxidation of CN to CO_2 and N_2 corresponded approximately to the value calculated on the basis of the nitrate formed.

TABLE III. OXIDATION OF CYANIDES TO CYANATES WITH HYPOCHLORITES

Run No.	Type of Cyanide Solution	Orig. CN ppm	Heavy Metal Ion ppm	Type of Reagent Used	Available Cl_2 lb per lb CN	Temp. Rise °C	Initial *p*H Value*	Final *p*H Value	Time of Reaction min	Final CN ppm
15	Na	98	0	NaOCl	2.73	<1	10.3	10.1	<2	<0.1
16	Na	181	0	NaOCl	2.73	<1	10.5	10.2	<3	0.1
17	Na	18,100	0	NaOCl	3.20	25	>11	>11	<3	0.2
2	Na	3.040	0	NaOCl	0.71	...	.....	.....	2	2170
3	Na	3,040	0	NaOCl	1.41	...	.....	.....	2	1170
4	Na	3,040	0	NaOCl	2.12	...	.....	.....	2	675
5	Na	3,040	0	NaOCl	2.73	...	.....	.....	2	<0.2
400	Na	5,000	0	$Ca(OCl)_2$	2.96	22	11.9	10.0	6	1250
									10	1040
									15	1040
									20	1040
401	Na	5,000	0	$Ca(OCl)_2$	3.70	...	11.9	9.1	5	570
									10	520
									15	442
402	Na	5,000	0	$Ca(OCl)_2$	5.55	23	11.9	8.5	5	78
									10	52
									30	52
403	Na	5,000	0	$Ca(OCl)_2$	2.96	18	>13[1]	12.7	5	<0.2
403a	Na	5,000	0	$Ca(OCl)_2$	2.96	...	>13[2]	12.5	20	585
29	Na-Zn	100	63.5	NaOCl	2.87	<1	11.5	11.4	<3	<0.1
30	Na-Zn	100	63.5	NaOCl	2.73	<1	11.5	11.4	<3	<0.1
8	Na-Zn	48,300	33,400	NaOCl	2.73	66	>11	>11	<3	0.3
9	Na-Zn	4,830	3,340	NaOCl	2.73	8	>11	>11	<3	0.2
13	Na-Zn	48,300	33,400	NaOCl	2.73	56	>11	>11	<3	0.1
14a	Na-Zn	48,300	33,400	NaOCl	2.73	56	>11	>11	<3	0.2
17	Na-Zn	484	334	NaOCl	2.73	<1	11.7	11.5	<3	0.2
413	Na-Zn	9,680	6,150	$Ca(OCl)_2$	2.98	31	>13	12.5	2	2180
414	Na-Zn	91	57.8	$Ca(OCl)_2$	2.88	<1	11.4	11.2	5	<0.5
415	Na-Zn	4,560	2,900	$Ca(OCl)_2$	2.88	11	>13	12.2	3	7.8
416	Na-Zn	4,560	2,900	$Ca(OCl)_2$	3.00	12	.....	.....	3	1.95
417	Na-Zn	4,560	2,900	$Ca(OCl)_2$	2.88	...	>13[3]	.....	2	0.15
31	Na-Cu	98	63.5	NaOCl	3.20[4]	<1	10.1	9.8	<3	0.15
32	Na-Cu	100	64.8	NaOCl	3.20[4]	<1	.....	.....	<3	<0.1
33	Na-Cu	491	319	NaOCl	3.10	<1	10.5	10.1	<3	0.7
18	Na-Cu	25,500	16,500	NaOCl	2.73	32	>11	>11	2	3200
1	Na-Cu	25,500	16,500	NaOCl	3.20[4]	34	>11	>11	2	0.2
407	Na-Cu	9,800	6,350	$Ca(OCl)_2$	3.20	...	11.6	7.6	4	16.9
408	Na-Cu	9,800	6,350	$Ca(OCl)_2$	3.20	...	>13[5]	7.9	2	26.2
409	Na-Cu	9,800	6,350	$Ca(OCl)_2$	3.20	...	>13[5]	12.6	2	<0.2
411	Na-Cu	98	63.5	$Ca(OCl)_2$	3.20	<1	10.5	8.5	3	2.1
412	Na-Cu	98	63.5	$Ca(OCl)_2$	3.20	<1	11.8[7]	11.5	3	<0.2
70	Na	5,000	0	$Ca(OCl)_2$	2.88	...	12.0	10.5	5	1040
									10	1040
									20[8]	1040
71	Na	5,000	0	$Ca(OCl)_2$	2.88	...	12.0	11.0	3[8]	1250
72	Na	5,900	0	$Ca(OCl)_2$†	2.98	...	12.0	11.4	3[9]	<0.1
73	Na	5,900	0	$Ca(OCl)_2$†	2.81	...	12.0	11.4	5[10]	<0.2
74	Na	5,900	0	$Ca(OCl)_2$†	4.68	...	12.0	6.2	3[11]	<0.2
75	Na	5,900	0	$Ca(OCl)_2$†	2.81	...	12.0	11.4	3[12]	<0.2
76	Na	2.950	0	$Ca(OCl)_2$†	7.80	...	11.9	.....	5[13]	<0.2
78	Na	5,900	0	$Ca(OCl)_2$†	3.90	...	12.0	6.85	3[8]	<0.2[16]
79	Na	2,950	0	$Ca(OCl)_2$†	7.80	...	11.9	6.40	1.5	<0.2[16]
80	Na	5,920	0	$Ca(OCl)_2$	2.80	...	12.0	8.90	3	1875[16]
									25	1535[17]
81	Na	2,960	0	$Ca(OCl)_2$	7.80	...	11.9	5.90	3	<0.2[16]
43	K-Ni	4,400	273	NaOCl	2.73	<5	12.2	12.0	10[19]	126
44	K-Ni	4,400	620	NaOCl	2.85	<5	11.9	11.7	5[20]	227
43a	K-Ni	4,400	273	NaOCl	2.85	<5	12.2	12.1	3[21]	234
43b	K-Ni	4,400	273	NaOCl	2.85	<5	12.2	12.1	15[19]	97
44a	K-Ni	4,570	620	NaOCl	3.03	<5	10.9	12.1	8	300
45	K-Ni	4,570	620	NaOCl	3.72	<5	11.0	12.1	8	11.7

TABLE III (*Continued*)

Run No.	Type of Cyanide Solution	Orig. CN ppm	Heavy Metal Ion ppm	Type of Reagent Used	Available Cl_2 lb per lb CN	Temp. Rise °C	Initial *p*H Value*	Final *p*H Value	Time of Reaction min	Final CN ppm
60	Na-Ni	935	226	NaOCl	3.40[22]	...	.....	11.2	20	7.02
62	Na-Ni	935	226	NaOCl	3.40[22]	...	.....	11.2	35	8.12
63	Na-Ni	935	226	NaOCl	3.90[23]	...	.....	11.3	40	0.821
175	Na-Cu	1,000	648	NaOCl	3.50	...	11.3	.....	3	<0.1[24]
175a	Na-Cu	1,000	648	NaOCl	3.50	...	11.3	.....	3	<0.1[25]
175b	Na-Cu	1,000	648	NaOCl	3.50	...	11.3	.....	3	<0.1[25]
176	Na-Zn	1,000	635	NaOCl	3.50	...	11.7	.....	3	<0.1[25]
176a	Na-Zn	1,000	635	NaOCl	3.50	...	11.7	.....	3	<0.1[24]
176b	Na-Zn	1,000	635	NaOCl	3.50	...	11.7	.....	3	<0.1[24]
163	Comm. Brass	400	Unknown	NaOCl	3.10	...	10.5	10.3	5	<0.2[26]
164	Comm. Na-Cd	400	Unknown	NaOCl	3.10	...	11.7	11.5	5	<0.2[27]
165	Comm. Na-Cu	400	Unknown	NaOCl	3.10	...	10.3	10.2	5	<0.1[24]
166	Comm. Na-Zn	400	Unknown	NaOCl	3.10	...	12.1	11.8	5	<0.1[29]

*The initial *p*H value of the solution was measured before the addition of the hypochlorite reagent.
†Added as liquid solution
[1]0.835, [2]0.468 lb NaOH added per lb CN
[3]0.246 lb NaOH added per lb CN in addition to the 1.5 lb NaOH already present per lb CN
[4]3.5% excess Cl_2
[5]0.307, [6]0.945, [7]0.85 lb NaOH added per lb CN
[8]Trace Cl_2 left in solution
[9]90.15, [10]98.75, [11]98.25, [12]98.3, [13]91.6% Cl_2 used for reaction
[14]27% CN completely oxidized
[15]CN completely oxidized—7.16 lb Cl_2 per lb CN
[16]25% CN completely oxidized
[17]99.6% Cl_2 used—4150 ppm CNO in 3 min
[18]CN completely oxidized—7.2 lb Cl_2 per lb CN
[19]No trace, [20]small trace, [21]considerable Cl_2 left
[25], [22]20% excess Cl_2
[23]99, [24]101.5, [25]87.7, [27]102, [28]93.3, [29]104% CN converted to CNO, by analysis of the latter

quirements were somewhat larger. As to the amount of caustic used, with the exception of the findings by Dobson[8], the information was either unavailable or incomplete.

b. For oxidation of cyanide beyond the cyanate stage, the chlorine and caustic soda requirements had been reported by Dobson; some information had also been reported by Dobrovolny *et al.*[9], but their information could hardly be compared with that of Dobson because the experiments had been carried out at an elevated temperature near boiling.

The question of formation of cyanogen chloride had been approached from two different angles. Whereas some investigators were concerned only with possible evolution of cyanogen chloride during and after treatment of cyanide solutions, others were concerned only with the retention and rate of decomposition of cyanogen chloride in the liquid. Furthermore, a wide range of operating *p*H values had been cited by different investigators as the optimum for the removal of cyanogen chloride, the figures varying anywhere from about 8.5 to 10.5.

Finally it should be pointed out that the data presented by each investigator covered only a portion of the variables which are encountered in electroplating solutions and wastes. Even if all of these different sources of information had been integrated, it would have been impossible to draw general and complete conclusions as to the effectiveness of this process and as to possible ways of solving the different problems which arise in the treatment of cyanide solutions of different types and concentrations.

With reference to the removal of cyanates by acid hydrolysis, the only available information was in the form of reaction equations, and to the best of our knowledge no experimental data were available on its possible application to the treatment of cyanide wastes.

* * *

At the completion of this investigation some very interesting additional information[15] on chlorination of cyanides came to the attention of the authors. This information was based on the results of investigations on hydrolysis of cyanogen chloride and oxidation of cyanides to cyanates in synthetic dilute plating solutions, sponsored by The Water Pollution Research Board in England. These results are summarized below:

1. Cyanide was completely removed from solutions buffered at a *p*H of 11 and containing potassium cyanide, potassium zinc cyanide, and potassium cadmium cyanide in concentrations equivalent to 96.3 ppm of CN by addition of calcium hypochlorite solution in an amount equivalent to 1 mole of available chloride per mole of CN or 2.73 lb per lb of CN. Additional hypochlorite was added to potassium cuprocyanide solutions in order to oxidize cuprous copper to the cupric state (Table II).
2. The hydrolysis of cyanogen chloride, which was formed as the first product of the oxidation, was found to be greatly accelerated by addition of a small excess of hypochlorite. At a *p*H of 11 and at 20° C (68° F), the presence of an excess of 4, 8, 16 ppm of available chlorine accelerated the rate of hydrolysis by approximately 2.5, 3.5 and 7 times respectively. At the same *p*H and temperature, a solution containing 25

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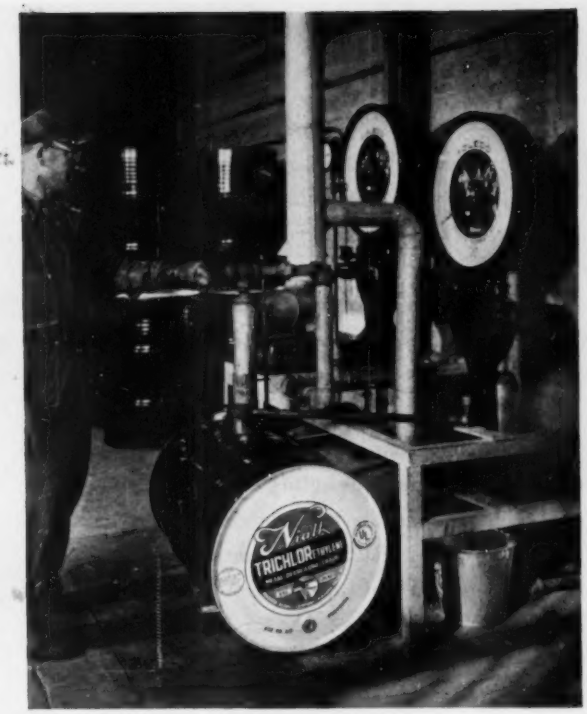

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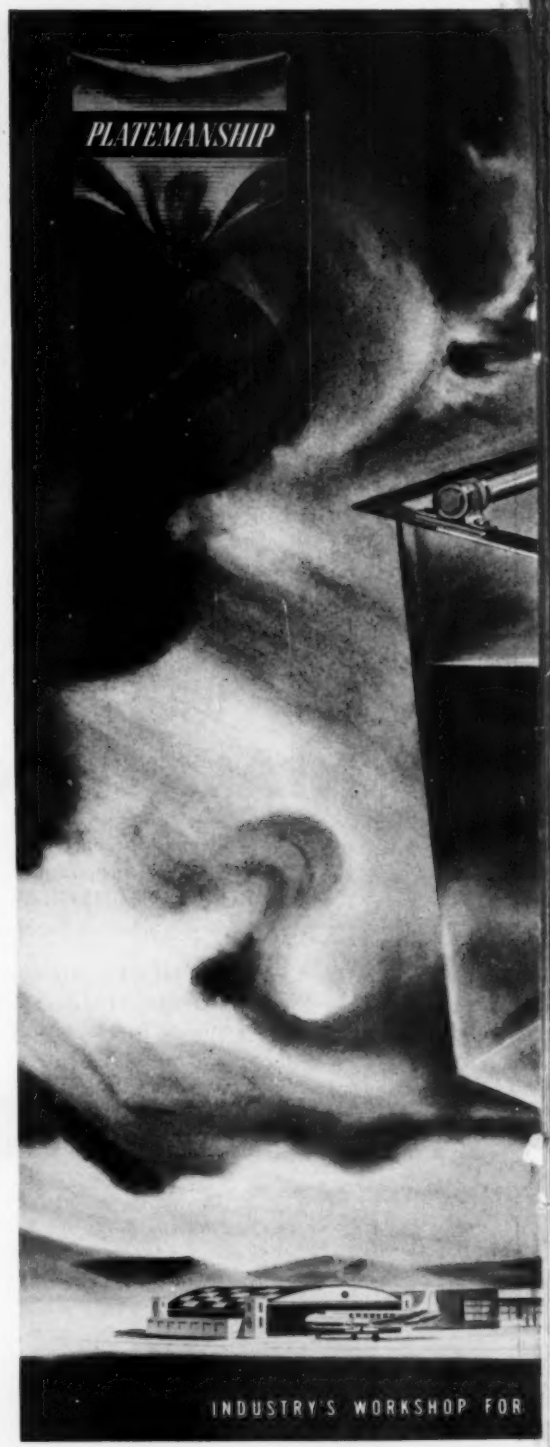

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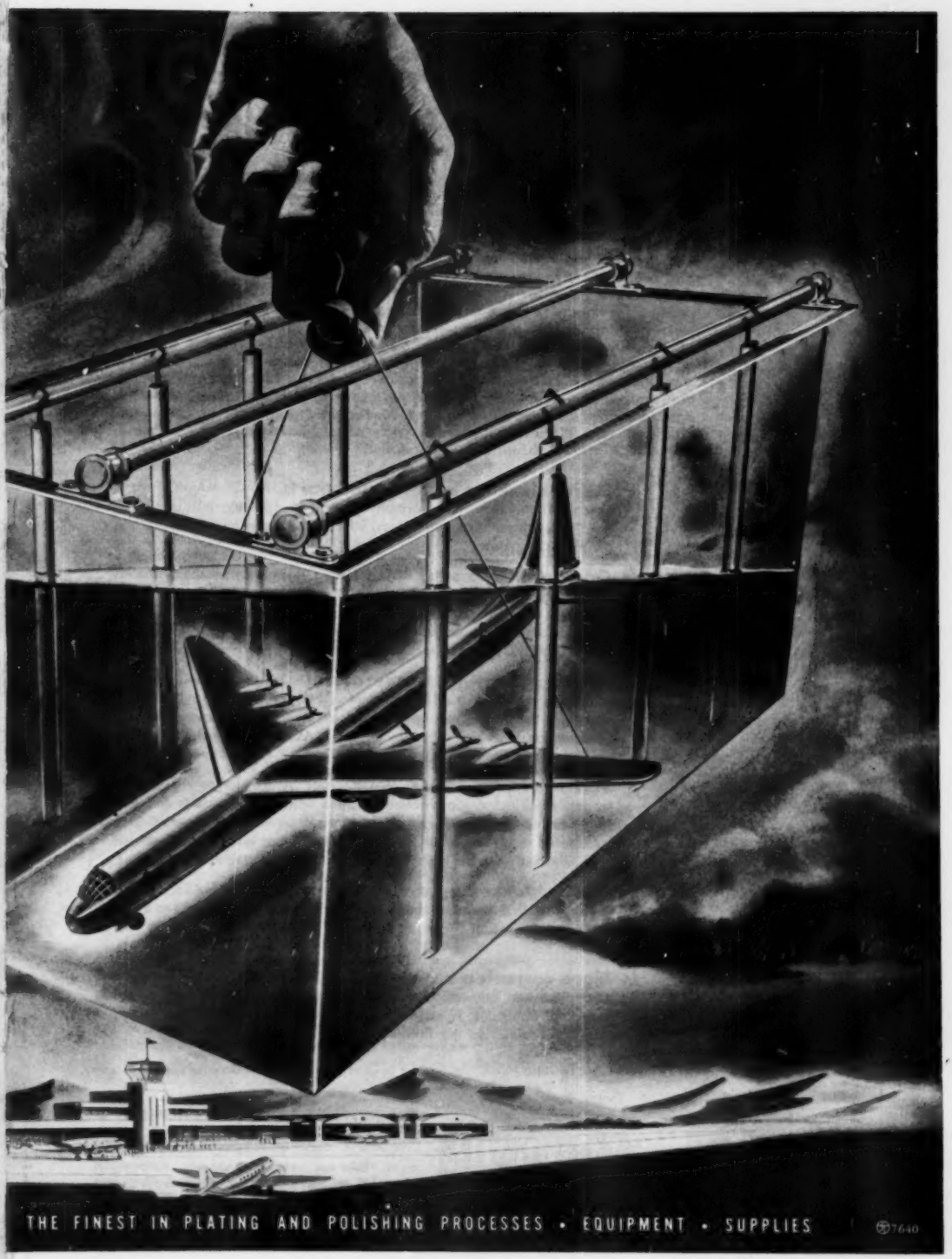
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TABLE IV. SLUDGE FORMATION UPON REACTION OF HYPOCHLORITES WITH CYANIDE SOLUTIONS

Run No.	Type of Cyanide Solution	Orig. Total CN ppm	Metal Ion ppm	Type of Reagent Used	Final* Volume of Settled Sludge %	Settling Time min	Final *p*H Value	Type of Metallic Precipitate Formed
400	Na	5,000	0	$Ca(OCl)_2$[1]	8	....	8.3	.....
401	Na	5,000	0	$Ca(OCl)_2$[3]	10	....	8.1	.....
428	Na-Zn	100	63.5	$Ca(OCl)_2$[3]	0.9	....	11.0	$Zn(OH)_2$
429	Na-Zn	100	63.5	NaOCl[2]	0.9	....	11.0	$Zn(OH)_2$
41	Na-Zn	4,560	2,900	NaOCl	4	<100	>12.0	$Zn(OH)_2$
415	Na-Zn	4,560	2,900	$Ca(OCl)_2$	11	<100	12.15	$Zn(OH)_2$
421	Na-Zn	45,600	29,000	NaOCl	4	....	>13	$Zn(OH)_2$
				[4]	9	....	>11.5	$ZnCO_3$
423	Na-Zn	45,600	29,000	NaOCl[4]	5	....	12.5	$Zn(OH)_2$
				[4]	9	....	11.4	$ZnCO_3$
				[4]	5	....	9.35	$ZnCO_3$
422	Na-Zn	45,600	29,000	NaOCl[4]	5	....	9.6	$ZnCO_3$
424	Na-Zn	45,600	29,000	$Ca(OCl)_2$	31	....	9.75	$ZnCO_3$
426	Na-Cu	92.5	60	NaOCl[3]	0.9	....	11.0	$CuCO_3$
427	Na-Cu	92.5	60	$Ca(OCl)_2$[3]	0.9	....	11.0	$CuCO_3$
40	Na-Cu	9,800	6,350	NaOCl	7	100	>12	CuO
405	Na-Cu	9,800	6,350	$Ca(OCl)_2$[5]	26	425	8.0	$CuCO_3$
406	Na-Cu	4,900	3,180	$Ca(OCl)_2$	29	425	7.5	$CuCO_3$
410	Na-Cu	9,800	6,350	$Ca(OCl)_2$[6]	37	....	<12	CuO
407	Na-Cu	9,800	6,360	$Ca(OCl)_2$	38	800	7.6	$CuCO_3$
408	Na-Cu	9,800	6,360	$Ca(OCl)_2$[7]	22	200	10.1	$CuCO_3$

*% settled sludge was determined on basis of final volume of treated solution.
[1]8.1, [3]33.1% $Ca(OCl)_2$ in excess of equimolar ratio
[2]Alkalinity regulated by addition of NaOH
[4]$NaHCO_3$ added
[5]0.34, [6]1.7, [7]0.74 lb NaOH added per lb CN

ppm of CNCl and no hypochlorite was hydrolyzed to a concentration of 0.1 ppm in about 30 minutes.

3. Temperature was found to increase the rate of hydrolysis. A change in temperature from 10 to 30° C (50 to 86° F) increased the rate of hydrolysis by about twelve times.
4. It was also found that a dangerously high concentration of cyanogen chloride was built up in the atmosphere over a solution containing only few parts per million of this compound. It was therefore suggested that chlorination of large batches of cyanide solutions be performed in covered tanks provided with means of extracting vapors of cyanogen chloride during the chlorination stage. It was further suggested that the chlorination equipment be installed in the open air.
5. Ferrocyanide, which is often present in plating baths, was found to have no effect on chlorination, although it was not decomposed by chlorination.
6. No experimental work was performed with cyanide solutions containing nickel, but it was stated that complex nickelo-cyanides would be slowly attacked by chlorine and would therefore interfere with the procedures outlined in the report. Hence it was suggested that solutions of nickel sulfate, obtained from effluents of nickel plating baths, be separated from cyanide effluents.

Apparatus, Analytical Procedures and Reagents

The apparatus used consisted of ordinary laboratory glassware. Most of the experimental runs were made in beakers of different sizes and the treated solutions were kept well stirred as the reagents were being added. Only where gases, produced during and after the reaction, were either measured or analyzed was more specialized equipment used. However, as it did not have any unique features it will not be discussed in this section; it will be briefly mentioned in a later section.

A Leeds & Northrup glass electrode *p*H meter was used for accurate *p*H measurements, *p*Hydrion paper for rough checks.

Cyanides were determined by the Modified Liebig Titrimetric Method using KI and p-dimethylaminobenzalrhodanine as indicators for macro and semimicro analysis respectively, and the Pyridine-Pyrazolone Method was used for micro determinations of either cyanides or cyanogen chloride. In most cases the solutions were distilled and their cyanide content determined by analysis of the distillate. Cyanates were analyzed by acidification followed by nesslerization. Detailed descriptions of these methods may be found in the joint report of A. E. S. Projects Nos. 2 and 10 on "Analytical Methods for the Quantitative Determination of Cyanides and Cyanates in Plating Wastes and in Effluents from Treatment Processes", to be published.

Residual chlorine was identified qualitatively with starch-potassium iodide paper indicator and determined qualitatively by iodometric titration with standard 0.1-*N* $Na_2S_2O_3$ solution. Copper and zinc ions were determined colorimetrically by the tetraethylene pentamine[4] and the mixed-color dithizone method[14], respectively.

A method of analysis was developed whereby it was possible to determine the correct quantities of hypochlorite ion or available chlorine to be used for oxidation of cyanide to cyanate without analyzing the solution for its cyanide content. This method consisted in titrating the solution at a *p*H higher than 11 with sodium hypochlorite solution until an excess of chlorine had been added, as shown with starch-potassium iodide indicating paper. The excess chlorine was then titrated iodometrically with standard sodium thiosulfate solution, using starch and KI. The method was found

TABLE V. SOLUBILITY OF COMMERCIAL CALCIUM HYPOCHLORITE IN WATER

Reagent Used	Wt of Reagent g*	Time of Agitation min	Settled Sludge % by vol	Temp. Rise °C	Available Cl_2 in Solution g/l	Available Cl_2 Dissolved %	Final *p*H Value
HTH†	10	5	..	<3	75.5	100.0	11.88
Pittchlor‡	10	3.5	9	<3	70.2	95.5	11.90
HTH†	10	3.5	9	<3	70.2	95.5	11.88
HTH†	25	3	20	<3	165.0	94.3	11.55
HTH†	25	5	20	9	173.5	98.0	11.55
Pittchlor‡	25	5	..	8	160.0	87.2	11.50
HTH†	50	5	36	..	213.0	61.0	11.35
Pittchlor‡	25	5	..	..	156.0	85.0	11.35
HTH†	50	20	..	..	213.0	61.0	11.35

*Dissolved in 100 ml of distilled water.
†Available Cl_2 in HTH = 75.5%
‡Available Cl_2 in Pittchlor = 73.5%

TABLE VI. THE FORMATION AND HYDROLYSIS OF CYANOGEN CHLORIDE

Run No.	Type of Cyanide Solution	Orig. Total CN ppm	Type of Reagent Used	Available Cl_2 lb per lb CN	Initial *p*H Value	Final *p*H Value	Time of Reaction min	Final CN ppm	Final CNCl ppm
48	K	100	Cl_2	2.8	11.85[1]	10.5	5	<0.1	<0.1
49	K	100	Cl_2	2.8	11.7[2]	6.8	5	<0.1	<0.1
50	K	100	Cl_2	2.8	11.7[3]	8.7	5	<0.1	<0.1
51	K	10	Cl_2	1.48	9.3	8.6	5	.....	8.55
						6.8	20 hr[4]	2.78	4.02
52	K	10	Cl_2	2.8	9.3	6.2	5	1.6	9.47
							110	<0.1	3.31
53	K	10	Cl_2	2.73	9.3	...	5	<0.1	.....
					[5]	10.2	6	<0.1	5.2
						...	11	<0.1	<0.1
54	K	10	Cl_2	2.9	9.3[6]	...	1	.....	.....
						7.4	2	.....	6.64
						...	10	.....	<0.1
55	Na	10	NaOCl	5.46	8.0[7]	8.0	5	<0.1	<0.1
56	Na	10	NaOCl	2.61	8.6[7]	8.6	5	.....	10.9
						8.6	10	.....	10.9
						8.6	15	.....	10.9
						8.6	90	.....	9.5
57	Na	10	NaOCl	2.75	8.6[7]	8.6	5	.....	11.6
						8.6	10	.....	9.5
				3.30[8]	8.6	8.6	15	.....	<0.1

[1]4, [2]2.8, [3]3.2, [5]1.6, [6]0.8 lb NaOH added per lb CN
[4]Solution in stoppered bottle
[7]H_3BO_3–NaOH buffer used
[8]20% excess NaOCl added

applicable to all fresh and waste plating solutions investigated with the exception of those containing nickel. It should be added that knowledge of the cyanide content of a solution may not necessarily suffice for the calculation of the amount of hypochlorite required for complete oxidation (see Table XVI, Runs 9, 10, 11) because other oxidizable matter may be present, especially in a waste solution.

The method can also be used for quick determination of the cyanide content of solutions containing nonoxidizable matter and known oxidizable metallic ions (Table XVI, Runs 1–8).

The solutions investigated in this research were pure alkali cyanide and cyanate solutions, synthetic and actual plating solutions. Their concentration was varied by dilution to between 10 and 50,000 ppm of total cyanide and total cyanate. The metallic ions investigated were zinc, copper, cadmium and nickel.

The compositions of the synthetic electroplating solutions used were the following:

1. *Copper plating bath* g/l
   Cuprous cyanide, $Cu_2(CN)_2$ ... 45
   Sodium cyanide ... 68
   Sodium carbonate ... 30

2. *Zinc plating bath*
   Zinc cyanide ... 60
   Sodium cyanide ... 41
   Caustic soda ... 79

3. *Cadmium plating bath*

Cadmium chloride ($CdCl_2$)	37.2
Sodium cyanide	109

The hypochlorite reagents used were (1) chlorinated water obtained by bubbling gaseous chlorine through distilled water, (2) commercial sodium hypochlorite solution with an initial concentration of about 15 per cent available chlorine, and (3) commercial solid calcium hypochlorite in granular form containing somewhat over 70 per cent available chlorine. It was found that the sodium hypochlorite solution, which was stored in a stoppered glass carboy in a lighted room where the temperature varied between 70 and 90° F (21 and 32° C), decomposed by about 67 per cent in eight months, whereas the decomposition of solid commercial calcium hypochlorite stored in either a metal or glass container was less than 1 per cent over a period of five months.

Discussion of Results

The experimental results will be discussed in this section. The presentation will be made under the following main headings, in order:

I. Oxidation of cyanides to cyanates
II. Formation and rate of hydrolysis of cyanogen chloride upon reaction of hypochlorites with cyanides
III. Removal of toxic metallic ions during and after oxidation of cyanides to cyanates
IV. Complete destruction of cyanides by oxidation beyond the cyanate stage
V. Complete removal of cyanates by acid hydrolysis

In all the experimental investigations the main variables studied were ratio of reagent to reactant, *p*H value, and time of contact. The effect of temperature on oxidation of cyanides to cyanates was not investigated in view of the excellent results obtained at room temperature and because of ample literature evidence to the effect that a temperature higher than 100° F (38° C) causes decomposition of hypochlorites into chlorates* and accelerates the rate of volatilization of such noxious gases as chlorine and cyanogen chloride, which may form during treatment of cyanides with hypochlorites. Temperature is of course known to accelerate the rate of hydrolysis of cyanates[2], but the use of elevated temperature in conjunction with the use of hypochlorites for treatment of cyanides would hardly be desirable in view of the decomposition of hypochlorites to chlorates and the high cost of heating dilute solutions.

TABLE VII. EVOLUTION OF CYANOGEN CHLORIDE FROM SODIUM CYANIDE SOLUTIONS TREATED WITH SODIUM HYPOCHLORITE

Run No.	Total CN ppm	Available Cl_2 lb per lb CN	Initial *p*H Value	Final *p*H Value	Amount CNCl Evolved mg/gal	Amount HCN Evolved mg/gal	Temp. Rise °C
200	98	5.46	10.5	10.4	0.74	0	0.5
201	98	2.73	10.5	10.2	1.21	0	0.5
202	9800	2.73	12.1	11.3	5.10	0	17
203	9800	2.73	8.3[1]	8.3	258	44.5	21

[1]Initial *p*H lowered from 12.1 to 8.3 by addition of H_3BO_3

I. *Oxidation of cyanides to cyanates*

The results of the experimental investigations of the oxidation of cyanides to cyanates with hypochlorites are shown in Table III. The effect of the main variables on such a reaction will now be considered.

a. *Time of reaction.*—It may readily be observed in Table III that the oxidation of cyanides to cyanates by hypochlorites is very rapid for every type of cyanide solution with the exception of those containing nickelous ion. In Runs 400–402, 70 and 80, where an alkali-metal cyanide solution was treated with calcium hypochlorite, the reaction was slow for reasons which will be explained later in this section. Whereas in most of the investigations the rate of reaction was studied by determining the residual cyanide content in the treated solution, in cyanide solutions containing the nickelous ion the rate of reaction was also checked by determining the consumption of available chlorine as a function of time. Results showed that whereas in all the other solutions the required amount of available chlorine was consumed very rapidly, in alkali-metal nickelo-cyanide solutions this process was very slow, requiring about one-half hour for completion of the reaction (Runs 45, 60, 62, 63). No explanation can be given at present for this be-

TABLE VIII. THE REMOVAL OF METALS FROM PLATING SOLUTIONS AFTER OXIDATION OF CYANIDE TO CYANATE WITH HYPOCHLORITES

Run No.	Type of Cyanide Solution	Total CN ppm	Orig. Heavy Metal ppm	Type of Reagent Used	Available Cl_2 lb per lb CN	Initial *p*H Value	Final *p*H Value	Final CN ppm	Final Heavy Metal ppm
418	Na-Zn	91.2	58	$Ca(OCl)_2$	2.88	11.4	11.1	0.2	>40
							7.8[2]	<0.1	4–5
419	Na-Zn	91.2	58	$Ca(OCl)_2$	2.88	11.4[2]	11.1	0.1	>40
							8.8	...	4–5
420	Na-Zn	91.2	58	$Ca(OCl)_2$	2.88	11.4[2]	11.1	0.1	>40
							9.0	...	4–5
421	Na-Zn	91.2	58	$Ca(OCl)_2$	2.88	11.4[2]	11.1	...	>40
							8.9	0.2	4–5
422	Na-Cu	98	63.5	$Ca(OCl)_2$	3.08	>12	11.5	<0.1	1.4

[1]CO_2 absorbed from air during 2 days. [2]Sodium bicarbonate added

*This is not confirmed by experimental results, such as Runs 8, 13 and 14a, Table III. It is possible that the rate of oxidation of CN to CNO by hypochlorites is much more rapid than the rate of decomposition of hypochlorites to chlorates.

TABLE IX. OXIDATION OF POTASSIUM CYANATE SOLUTIONS WITH SODIUM HYPOCHLORITE. A STUDY OF THE EXTENT OF OXIDATION ON THE BASIS OF THE GAS (N_2) EVOLVED AT ROOM TEMPERATURE

Run No.	Solution Vol. ml	Initial KCNO ppm	Available Cl_2 mole per mole KCNO	Time hr	Gas Vol ml	KCNO Decomposed %	Initial, Intermediate and Final *p*H values
101	50	6200	1.5	0	0	0	9.5
				0.1	2.1	4.5	12.2
				0.3	3.8	8.1	9.4
				1.3	6.6	14.1	
				2.0	8.1	17.3	
				3.1	12.5	26.6	
				4.4	20.7	44.5	
				6.1	23.7	50.5	
				24.2	45.0	95.8	
				27.6	45.5	97.0	
102	25	6200	0.5	0	0	0	9.6
				0.4	6.1	25.9	12.0
				1.0	8.3	35.2	9.5
				1.9	9.9	42.5	
				4.0	11.8	50.0	
				5.0	12.4	52.6	
				6.5	13.0	55.1	
				24.0	13.7	55.1	
				26.1	13.7	55.1	
				27.8	13.7	55.1	
103	25	620	10	0	0	0	7.4
				0.3	0.3	12.8	11.2
				3.8	0.8	34.0	7.4
				21.8	2.2	93.6	
104	25	6200	2	0	0	0	9.6
				0.9	0.9	3.8	11.5
				1.8	1.3	5.5	9.6
				3.1	1.8	7.7	
				16.3	16.4	70.0	
				23.0	17.9	76.3	
				27.0	20.5	87.5	

(*Continued on next page*)

havior. It was observed, however, that the nickelous ion in aqueous nickel chloride solutions was oxidized very rapidly by the hypochlorite ion, whereas in the presence of 1000–5000 ppm of cyanide the first evidence of an initial breakdown of the complex ion, as shown by the formation of a black precipitate of nickel oxide, was noticed only about 2–3 minutes after addition of the hypochlorite reagent. In zinc, brass, cadmium, or copper plating solution, the breakdown of the complex ion was much more rapid, and the reaction was completed in less than five minutes.

b. *Ratio of reagent to reactant.*—The amount of available chlorine necessary to oxidize cyanide to cyanate is 2.73 lb per lb of cyanide (CN). Preliminary investigations, the results of which are not tabulated in this report, had indicated this to be the minimum amount for oxidation, in accordance with the stoichiometry of the reaction as shown by equation 1.

The reason for the larger amounts of available chlorine necessary for the oxidation of cyanide in solutions containing copper or nickel is that these metallic ions are oxidized from a lower to a higher valence stage, thus consuming some of the hypochlorite added. The same would apply to any other oxidizable metallic ion present in a cyanide solution.

For the treatment of a copper plating solution the amount of reagent necessary is about 3.15 lb of available chlorine per lb of cyanide (CN), or an excess of about 15 per cent. This excess depends entirely on the concentration of copper and may therefore vary with the type of copper plating solution being treated. Experimental work has indicated that the amount of hypochlorite necessary to oxidize the cuprous ion to the cupric ion follows the stoichiometry of the reaction, in which one mole of hypochlorite oxidizes two moles of cuprous ion.

In the treatment of a cyanide solution in the presence of a nickelous salt it was

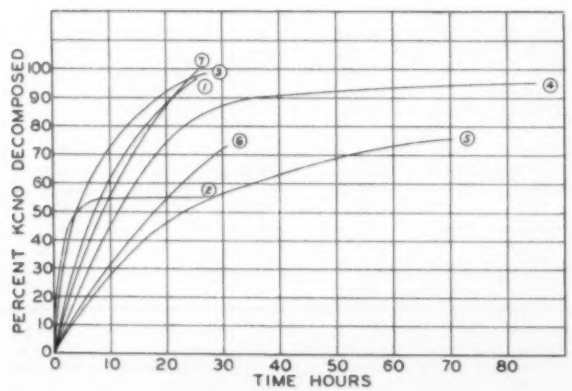


Fig. 1. Oxidation of potassium cyanate in aqueous solutions by sodium hypochlorite, as measured by the volume of nitrogen evolved at 1 atm and 25° C

Curve No.	*Initial KCNO ppm*	*Molar Ratio NaOCl/KCNO*	*pH*
1	*6,200*	*1.5*	*12.2–9.4*
2	*6,200*	*0.5*	*12.0–9.5*
3	*6,200*	*10.0*	*11.2–7.4*
4	*6,200*	*2.0*	*11.5–9.6*
5	*2,000*	*1.2*	*11.3–9.6*
6	*2,000*	*2.4*	*11.5–9.6*
7	*200*	*2.4*	*11.0–7.2*

found necessary to add an excess of hypochlorite in order to oxidize the nickel. Our investigations have shown that the amount of reagent consumed in the presence of the nickelous ion whether in the absence or presence of cyanide is about 3.5–3.7 times the theoretical amount for the oxidation of nickelous ion to nickelic, or 2.12–2.24 lb of available chlorine per lb of nickelous ion. Runs 60–62 show that 5 per cent excess of chlorine, calculated on the basis of the cyanide and nickel present, is insufficient for the complete removal of the cyanide in relatively short time. Run 63, Table III, shows that a 20 per cent excess is necessary for the almost complete removal of cyanide over a period of about 40 minutes.

c. *pH value.*—Most of the experiments took place at *p*H values higher than 10. It has been found that an operating *p*H within the range of 10–12.5 does not have any measurable effect on the rate of oxidation of cyanides to cyanates. It is not advisable to operate at *p*H values lower than 10 because the rate of hydrolysis of cyanogen chloride, which is always formed as an intermediate product of this oxidation, decreases quite rapidly as the *p*H decreases. This and other related subjects will be discussed in another section.

In the presence of the theoretical amount and even a small (5 per cent) excess of hypochlorite and at a *p*H higher than 10, all of the cyanide ion is first oxidized to cyanate, and no appreciable oxidation of the cyanate will occur until all of the cyanide has been oxidized.

The *p*H value of cyanide solutions treated with sodium hypochlorite remains approximately constant during treatment, as shown in Table III. However, when chlorine or calcium hypochlorite is used, the *p*H value of the treated solution may decrease considerably. (See Runs 400–402, Table III.) This fact is readily understood in the case of chlorine, be-

TABLE IX.

(Continued)

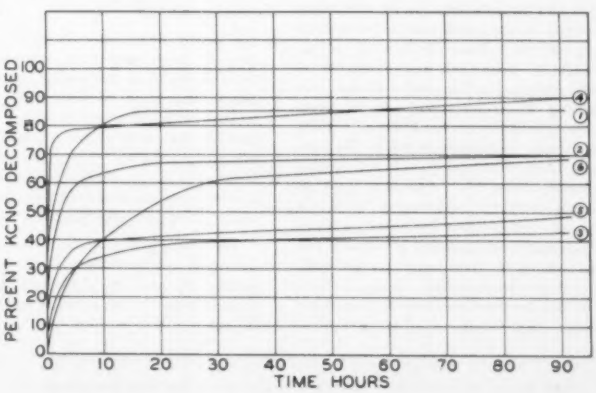
Run No.	Solution Vol ml	Initial KCNO ppm	Available Cl_2 mole per mole KCNO	Time hr	Gas Vol ml	KCNO decomposed %	Initial, Intermediate and Final *p*H values
				51.0	21.4	91.2	
				95.5	21.4	91.2	
				119.5	23.0	98.0	
105	100	2000	1.2	0	0	0	9.6
				1.0	1.1	3.6	11.3
				2.7	1.8	5.9	9.6
				5.5	4.4	14.5	
				7.0	5.7	18.8	
				22.1	15.6	51.0	
				25.2	16.7	55.0	
				47.2	20.3	66.8	
				52.3	21.6	71.0	
				70.9	23.1	75.7	
106	100	2000	2.4	0	0	0	9.6
				0.1	1.2	3.9	11.5
				1.1	1.4	4.6	9.6
				2.3	1.5	4.9	
				4.0	1.7	5.6	
				23.8	19.1	62.8	
				26.7	20.5	67.5	
				29.5	21.8	71.7	
107	150	200	2.4	0	0	0	7.2
				0.4	0.9	19.8	11.0
				1.1	1.0	22.1	7.2
				4.0	1.3	28.8	
				5.8	1.5	33.2	
				23.9	4.0	88.5	
				24.0		98.1†	

*Intermediate *p*H value refers to reading taken after addition of hypochlorite.

†This value was determined by nesslerization.

Fig. 2. Oxidation of potassium cyanate in aqueous solutions by sodium hypochlorite at room temperature

Curve No.	*Initial KCNO ppm*	*Molar Ratio NaOCl/KCNO*	*pH*
1	*10,000*	*1.3*	*12.5–9.4*
2	*10,000*	*1.0*	*12.3–9.4*
3	*10,000*	*0.5*	*12.4–9.4*
4	*50,000*	*1.0*	*12.5–9.4*
5	*50,000*	*0.5*	*12.1–9.4*
6	*1,000*	*1.0*	*11.0–9.4*



cause HCl is liberated as a result of the oxidation. In order to keep the *p*H constant in this particular case, it is necessary to add 3.08 lb of NaOH per lb of CN which is to be oxidized. This is the stoichiometric amount which will neutralize the HCl formed.

When calcium hypochlorite is used the situation is somewhat different. Although commercial calcium hypochlorite (HTH) contains about 2.7 per cent calcium hydrate, the hydroxide content is not high enough for neutralization of the hydrogen ion liberated by the hydrolysis of the calcium chloride formed during the reaction. It is therefore necessary to add a relatively small amount of some sodium hydroxide to maintain the *p*H value of the treated solutions approximately constant and above 10. The amount of sodium hydroxide used is a function of the concentration of cyanide and the type of solution treated. The results of Runs 400–402, Table III, in which calcium hypochlorite was added to alkali-metal cyanide solutions as a solid, puzzled the authors for some time, because of the incomplete removal of cyanide when considerable excess (8–103 per cent) of available chlorine was used. In Run 402, an analysis was made of the amount of residual chlorine. Although more than a trace had been left in solution, about 60 per cent was unaccounted for. It had also been noticed that upon addition of the solid calcium hypochlorite to the cyanide solution white fumes formed with a strong chlorine odor. Although it was hardly expected that all of the unaccounted-for chlorine had been volatilized, these fumes were analyzed quantitatively and found to account for a loss of less than 0.1 per cent of the original amount of available chlorine used. At this point it was felt that it was important to continue the study of the reaction between calcium hypochlorite and cyanide, because on the basis of previous results obtained when treating the cyanide ion with sodium hypochlorite, no plausible reason could be found for the different behavior of calcium hypochlorite which in solution made available the hypochlorite ion as the active reagent in the same manner as sodium hypochlorite. Runs 70 and 71, in the middle of Table III, reproduced the results obtained in Run 400. It was then decided to dissolve the calcium hypochlorite in water, filter off the precipitate of calcium hydroxide, and add the solution slowly, with agitation, to the cyanide solution. Runs 72–75 show that this time the removal of cyanide was complete. It was also noticed that the violent frothing which had been observed previously was not evident in these runs. At this point it was conjectured that violent frothing was due to the formation of a gas, and in as much as the amount of evolved chlorine was relatively small, this gas could only be nitrogen or carbon dioxide. This would mean that some of the cyanate formed was rapidly oxidized to nitrogen and carbon dioxide. Runs 78 and 79, in which a solution of calcium hypochlorite was added, showed that the oxidation of cyanate was also rapid, and Run 80, in which solid calcium hypochlorite was added in sufficient quantity to oxidize all of the cyanide and some of the cyanate, showed that some of the cyanate was oxidized before all of the cyanide had been removed from the solution. In Run 81, in which the amount of solid calcium hypochlorite used was adequate to oxidize all of the cyanide, complete removal of cyanide and cyanate was obtained in less than three minutes. Also, in Runs 78–81 it may be seen that the *p*H of the treated solution decreased considerably and that the oxidation of cyanate was very rapid at acidic *p*H values. These investigations enabled us to explain the incomplete removal of cyanide when solid calcium hypochlorite is used even in quantities somewhat larger than the theoretical amount required for oxidation of cyanide to cyanate, the reason being that upon addition of the solid particles of reagent (which did not dissolve instantaneously), localized regions with an acidic *p*H value were created in the treated solution, causing the hypochlorite to be used for oxidation of the cyanate formed before all of the cyanide had been converted into cyanate.

d. *Temperature.*—The oxidation of cyanides by hypochlorites is an exothermic reaction, hence the appreciable temperature rise in solutions containing more than 5000 ppm of cyanide. When solid calcium hypochlorite is used for treatment of cyanides, the temperature rise is somewhat larger than with sodium hypochlorite solutions, because the heat of solution is added to the heat of reaction. The temperature rise is less than 5° C (9° F) during the treatment of alkali-metal cyanide solutions containing less than 1000 ppm of CN and less than 20° C (36° F) for solutions containing less than 5000 ppm of CN.

e. *Sludge formation.*—As shown in Table IV, more sludge is formed when cyanide solutions containing more than about 2000 ppm of total cyanide are treated with commercial calcium hypochlorite than with either chlorine or sodium hypochlorite. The reason for the increase in sludge volume is the presence of some calcium hydrate in the reagent, which is only slightly soluble in water.

The sludge formation due to the calcium hydroxide can be eliminated almost completely by previous dissolving of solid calcium hypochlorite in water and adding of the solution to the cyanide waste. Table V shows that calcium hypochlorite dissolves readily in water and that a saturated solution contains about 213 g/l of reagent. The removal of sludge formed in this process should be relatively simple in view of the small volume of solution usually prepared.

The amount of sludge caused by metals alone is about 1 per cent by volume in solutions containing 60–70 ppm of metallic ion (Table IV, Runs 426 and 429). A comparison between Runs 426, 428 and 427, 429 shows that the same amount of sludge is obtained in the treatment of very dilute metallo-cyanide solutions by either sodium or calcium hypochlorite.

Another interesting point is that most of the precipitate settles very rapidly.

II. *Formation and rate of hydrolysis of cyanogen chloride upon reaction of hypochlorites with cyanides*

Table VI shows the results of experimental work on the formation and rate of hydrolysis of cyanogen chloride (CNCl) in cyanide solutions which have been treated by the amount of hypochlorite theoretically necessary to oxidize cyanide to cyanate and by an excess. The results indicate that at a *p*H higher than 9 and with a slight (1–2 per cent) excess of hypochlorite cyanogen chloride will hydrolyze in less than five minutes*. As the *p*H value decreases the rate of hydrolysis also decreases. However, even at *p*H values lower than 9 it is possible to hydrolyze cyanogen chloride in less than five minutes by using a larger excess of hypochlorite (Table VI, Runs 55 and 57).

Table VII shows that during the addition of hypochlorite some CNCl is evolved even at *p*H values higher than 10.5 and that at a *p*H value of 8.2 the amount of CNCl is about 25 times the amount volatilized at a *p*H of about 11.5 (Runs 203 and 202). These data again show that hydrolysis of CNCl at a highly alkaline *p*H is considerably faster than at a low alkaline *p*H. In these investigations CNCl was volatilized by gentle bubbling of air through the cyanide solution during treatment. It was absorbed in a weakly alkaline solution of *p*H 8. In industrial treatment of cyanides the solution would not be aerated but only exposed to the air above it; therefore, the amount of volatilized CNCl would be less.

III. *Removal of toxic metallic ions during and after oxidation of cyanides to cyanates*

Most metallic ions which are present in common electroplating solutions or wastes are so toxic that only very small quantities are tolerated by aquatic life. Moreover, their presence beyond certain minimum concentrations interferes with ordinary municipal sewage-disposal treatments. Be-

*At *p*H values higher than 10, CNCl hydrolyzes in less than 2 minutes.

cause of this, tentative state regulations have been or are in the process of being made regarding the maximum allowable concentration at or near the point of discharge in streams.

To give an approximate idea of the toxicity of copper and zinc to aquatic life it may be stated that the toxic concentrations of these two metals are reported as being 0.1–0.2 ppm for small trout, salmon and roach[12]. This value will of course vary, depending on the type and size of fish exposed, temperature, *p*H value, and amount of oxygen dissolved in the stream.

Experimental results, as shown in Table VIII, indicate that the concentration of copper left in the supernatant liquid after treatment of a cyanide solution with hypochlorite is about 1.5 ppm at a *p*H value of 11.45. A variation in *p*H between 8 and 12.5 should hardly affect this value, because the copper ion is only very slightly amphoteric. However, because of the alkalinity of the treated solutions and the formation of soluble zincate ion in alkaline solutions, the amount of zinc left in solution is considerable. It is therefore necessary either to lower the *p*H of the solution to about 9 by dilution to precipitate $Zn(OH)_2$ almost totally or to neutralize the hydroxide with sodium bicarbonate to form carbonate and precipitate the very slightly soluble $ZnCO_3$. The same precipitate may be obtained by addition of soda ash.

IV. *Complete destruction of cyanides by oxidation beyond the cyanate stage*

The oxidation of alkali-metal cyanates by hypochlorites was first studied by determining the volume of gases liberated during reaction. These gases were assumed to consist mainly of nitrogen (see equation 4) because they had been found to contain no measurable quantities of either ammonia or carbon dioxide. Although CO_2 was formed, it did not escape due to alkalinity of the solution. The measurements were made with a 100-ml mercury-filled burette connected to a water-filled U-tube manometer with one lend open to the atmosphere, which enabled one to measure the volume of gas produced at the pressure and temperature existing in the surroundings. The reaction was per force carried out in a closed system, and there was a limitation to either the volume or concentration of the solution to be treated. This method of analysis had been chosen, in preference to the perhaps more accurate Kjeldahl procedure, because it did not require much attention and it enabled one to determine the extent of decomposition of the cyanate ion without disturbing the system under investigation. However, a very quick method of analysis for cyanate was developed later, namely the nesslerization method, which enabled us to analyze many samples at the same time irrespective of the concentration. This method was immediately adopted for subsequent investigations.

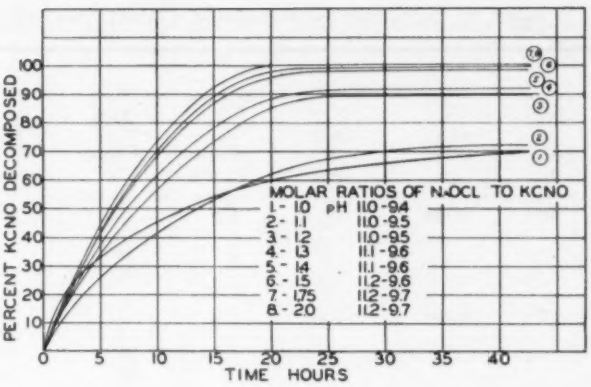


Fig. 3. Effect of ratio of reagent to reactant on oxidation of potassium cyanate in aqueous solutions, 1000 ppm, at room temperature

In Fig. 1, which contains the graphical representation of Runs 101–107 in Table IX, it may be observed that the rate of oxidation of cyanate is very low relative to that of cyanide and that more than one mole of hypochlorite is necessary to oxidize completely one mole of cyanate. The reactions were started at *p*H values higher than 11, and it may be assumed that most of the reaction took place at a highly alkaline *p*H value. However, since these results may not be too reliable, it is not safe to try to reach any conclusions. From Fig. 2, which shows the amount of cyanate destroyed at any time, the residual cyanate having been determined by nesslerization, and from Runs 109–115 of Table X, the following conclusions may be drawn:

a. The rate of oxidation is relatively rapid at first, but in most cases it drops off sharply after about 2 hours.
b. The rate of oxidation was initially higher in the more concentrated solutions than in the more dilute solutions (compare curves 4, 2, 6, Fig. 2). This can perhaps be ascribed to the larger temperature rise in the treatment of the more concentrated solutions, the reaction being exothermic, and to consequent partial decomposition of the cyanate through accelerated rate of hydrolysis[8].
c. The results again indicated that the reaction was very slow and that more than one mole of hypochlorite was necessary to completely oxidize one mole of cyanate.

A study of the amount of hypochlorite necessary to oxidize completely one mole of cyanate is clearly illustrated by Fig. 3,

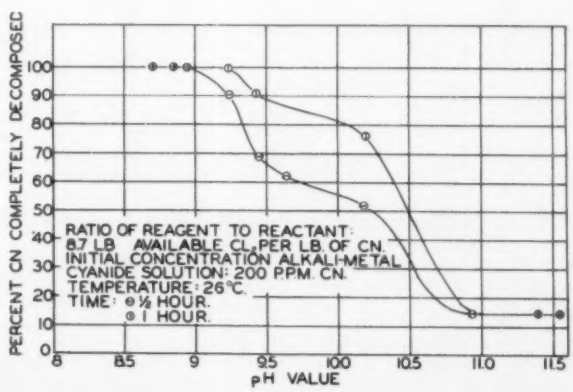

PERCENT CN COMPLETELY DECOMPOSED
pH VALUE
RATIO OF REAGENT TO REACTANT:
8.7 LB. AVAILABLE CL2 PER LB. OF CN.
INITIAL CONCENTRATION ALKALI-METAL CYANIDE SOLUTION: 200 PPM. CN.
TEMPERATURE: 26°C.
TIME: ⊖ ½ HOUR.
⊙ 1 HOUR.

Fig. 4. Effect of pH on rate of oxidation of cyanides in aqueous solutions to carbon dioxide and nitrogen. The pH value was regulated by a H_3BO_3–NaOH buffer

TABLE X. OXIDATION OF POTASSIUM CYANATE SOLUTIONS WITH SODIUM HYPOCHLORITE

Run No.	Orig. KCNO ppm	Initial *p*H Value	Available Cl_2 mole per mole KCNO	Time of Reaction hr	Final KCNO ppm	KCNO decomposed %	Final *p*H Value	Temp. Rise °C
109	10,000	12.5	1.3	1	4,300	57.0	9.4	<5
				3	4,280	57.2		
				21[1]	1,530	84.7		
				102	1,480	85.6		
110	10,000	12.3	1.0	1	7,300	27.0	9.4	<5
				3	3,840	61.6		
				21[1]	3,300	67.0		
				102	2,950	70.5		
111	10,000	12.0	0.5	1	8,850	11.5	9.4	<5
				3	6,560	34.4		
				21[1]	6,125	38.8		
				102	5,440	45.6		
112	50,000	12.5	1.0	0.5	12,200	75.6	9.4	30
				2.3	11,600	76.8		
				20.5[1]	9,650	80.7		
				100.0	3,540	92.9		
113	50,000	12.4	0.5	0.5	31,800	36.4	9.4	20
				2.3[1]	32,000	36.3		
				20.5	29,700	40.6		
				100.0	24,340	51.3		
115	1,000	11.0	1.0	1	870	13.0	9.4	<1
				2.8	745	25.5		
				20[1]	485	51.5		
				26	344	65.6		
				44.5	296	70.4		
116	1,000	11.0	1.1	1	895	10.5	9.5	<1
				2.8	858	14.0		
				20[1]	430	57.0		
				26	312	68.8		
				44.5	272	72.8		
117	1,000	11.0	1.2	1	895	10.5	9.5	<1
				2.8	858	14.0		
				20[1]	126	87.4		
				26	116	88.4		
				44.5	113	88.7		
118	1,000	11.1	1.3	1	875	12.5	9.5	<1
				2.8	858	14.2		
				20[1]	98	90.2		
				26	83	91.7		
				44.5	83	91.7		
119	1,000	11.1	1.4	1	890	11.0	9.6	<1
				2.75	...	...		
				20[2]	39.3	96.1		
				26	30.8	96.9		
				44.5	31.4	96.9		
120	1,000	11.2	1.5	1	890	11.0	9.6	<1
				2.75	848	15.2		
				20[2]	43	95.7		
				26	38	96.2		
				44.5	9.7	99.0		

TABLE X (*Continued*)

Run No.	Orig. KCNO ppm	Initial *p*H Value	Available Cl_2 mole per mole KCNO	Time of Reaction hr	Final KCNO ppm	KCNO decomposed %	Final *p*H Value	Temp. Rise °C
121	1,000	11.2	1.75	1	900	0	9.7	<1
				2.8	897	10		
				20[4]	<5	100		
122	1,000	11.2	2.0	1	890	11	9.7	<1
				2.8	...	....		
				20[4]	<2	100		
123	1,000	11.2	1.5	0.08	950	5	...	...
				0.17	950	5		
				0.25	940	6		
				0.33	930	7		
133	10,000	>12.5[5]	1.3	1	8,150	18.5	>12.5	<1
134	50,000	>12.5[5]	1.3	1	25,400	49.2[6]	>12.5	<1
135	1,000	>12.5[5]	1.3	1	500	50[7]	>12.5	<1
136	100	>12.5[5]	1.3	1	31.5	68.5[8]	>12.5	<1
137	1,000	>11	1.3[9]	2	685	31.5	>11	<
138	100	>11	1.3[10]	2	37	63	>11	<1
191	195	7.7[11]	2.3	0.5	16.4	91.6	7.7	<1
				1.0[13]	12.3	93.7	7.7	
192	195	11.1	2.3	0.5	181	7.7	...	<1
				1.0	181	7.7	10.5	
193	195	7.85[11]	2.3	0.5	16.4	91.6	7.85	<1
				1.0[14]	14.1	92.8	7.85	
194	195	8.35[12]	2.3	0.5	14.2	92.7	8.35	<1
				1.0[15]	10.5	94.6	8.35	
195	195	8.6[12]	2.3	0.5	21.0	89.2	8.6	<1
				1.0[16]	14.2	92.7	8.6	
196	195	9.15[12]	2.3	0.5	96.6	50.4	9.15	<1
				1.0[17]	75.2	61.4	9.15	
197	195	9.55[12]	2.3	0.5	167.5	14.0	9.55	<1
				1.0[18]	147.5	24.5	9.55	

[1]No trace, [2]small trace, [3]some, [4]appreciable Cl_2 after this period of time
[5]0.005 lb NaOH per lb KCNO
[6]27.0, [7]43, [8]48 per cent KCNO hydrolyzed
[9]0.1, [10]1 lb $Co(NO_3)_2$ per lb KCNO
[11]NaOH–KH_2PO_4 buffer used
[12]NaOH–H_3BO_3 buffer used
[13]7.88, [14]7.77, [15]7.92, [16]7.67, [17]7.58, [18]7.39 lb Cl_2 used per lb CN, as calculated from experimental results on the assumption that the oxidation of CN^- to CNO^- requires 2.73 lb available Cl_2 per lb CN.

in which Runs 115–122, Table X, are graphically represented. They show that somewhat more than 1.5 mole of hypochlorite is necessary to oxidize one mole of cyanate. According to equation 4, the theoretical molar ratio of reagent to reactant is 1.5. In these particular runs the reaction took place at an initially high *p*H value and was very slow.

A study of the effect of the *p*H on the rate of oxidation of cyanate or on the rate of oxidation of cyanide beyond the cyanate stage is illustrated by Figs. 4, 5, and 6. These graphs show that it is possible to oxidize cyanide or cyanate completely with hypochlorite in about one hour at a *p*H of about 8.5. Actually most of the oxidation will occur during the first half-hour. Furthermore, the rate of oxidation of cyanates at a *p*H value above 11 is very low and about constant for the same concentration of cyanate. Between *p*H values of 9 and 10.5 the rate of oxidation increases rapidly as the *p*H decreases.

An investigation of the three graphs shows a certain discrepancy from a quantitative point of view, although they check qualitatively. This discrepancy may be due in part to the experimental error of the runs and in part to the fact that different excesses of reagent were used for each group of determinations. As shown in Fig. 7, the smaller the excess of reagent, the lower is the rate of oxidation. Finally, the use of three different types of buffers, i.e., NaOH–H_3BO_3,

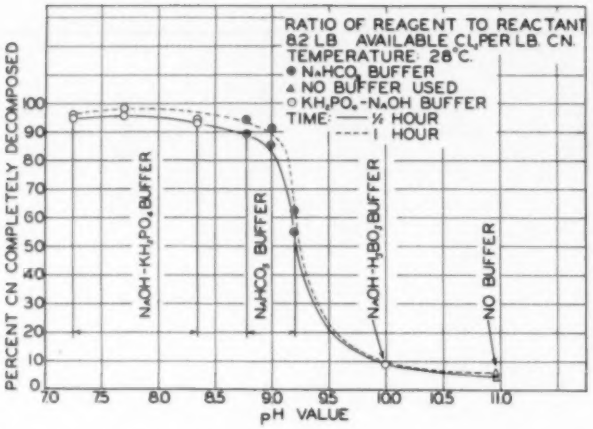


Fig. 5. Effect of pH on rate of oxidation of cyanides in aqueous solutions, 100 ppm, to carbon dioxide and nitrogen

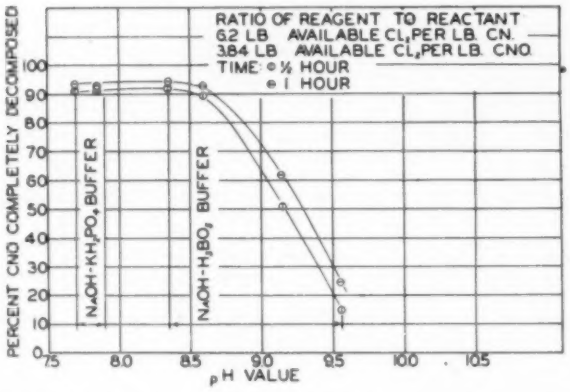

RATIO OF REAGENT TO REACTANT
6.2 LB. AVAILABLE Cl₂ PER LB. CN.
3.84 LB. AVAILABLE Cl₂ PER LB. CNO.
TIME: ○ ½ HOUR
● 1 HOUR
NaOH-KH₂PO₄ BUFFER
NaOH-H₃BO₃ BUFFER
PERCENT CNO COMPLETELY DECOMPOSED
pH VALUE

Fig. 6. Effect of pH on rate of oxidation of potassium cyanate in aqueous solutions (100 ppm CNO) at room temperature

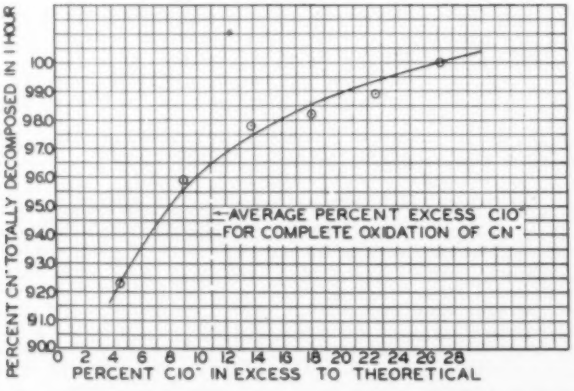

AVERAGE PERCENT EXCESS ClO⁻
FOR COMPLETE OXIDATION OF CN⁻
PERCENT CN⁻ TOTALLY DECOMPOSED IN 1 HOUR
PERCENT ClO⁻ IN EXCESS TO THEORETICAL

Fig. 7. Effect of excess hypochlorite on rate of oxidation of cyanides in aqueous solutions to carbon dioxide and nitrogen at room temperature and pH 8.7–8.85

$NaHCO_3$ and $NaOH$-KH_2PO_4, may have had some effect, although possibly not large, on the rate of oxidation of cyanates with hypochlorites[14].

It would also seem that this reaction is very rapid at slightly acidic *p*H values, as previously indicated in Table III, Runs 79 and 81, and as indicated in Table XI, Runs 128–131. The reaction between cyanates and hypochlorites in an acid medium may be expressed by the following equation:

$$2CNO^- + 2H^+ + 3ClO^- \longrightarrow N_2 + 2CO_2 + 3Cl^- + H_2O \quad (8)$$

From Tables X and XIII it appears that the average value of the ratio of reagent to reactant necessary to destroy cyanide completely is 7.6 lb of available Cl_2 per lb of CN. This value was determined from a series of 34 experimental runs with maximum deviations from the mean of −12.4 and +10.4 per cent. It is somewhat higher than the value of 7.35 proposed by Dobson[3], and it is about 11 per cent higher than the theoretical value of 6.82.

If chlorine is used, the caustic soda requirement, on a molar basis, will be about 1.6 times the amount of chlorine. In as much as 2.78 moles of Cl_2 are required per mole of CN, the caustic soda requirement should be about 4.45 moles of NaOH per mole of CN or 6.85 lb of NaOH per lb of CN. If calcium hypochlorite is used, some caustic should perhaps be added for the oxidation of cyanate, because, as shown in Table XI, the *p*H value of the solution being treated may decrease considerably. However, as there is no danger of formation of NCl_3 at *p*H values higher than 5, a decrease in *p*H would appear beneficial; the reagent requirement becomes less than the theoretical (see Runs 128–131, Table XI) because some of the cyanate is hydrolyzed rather rapidly at a slightly acidic *p*H, possibly according to this reaction:

$$CNO^- + H^+ + H_2O = CO_2 + NH_3 \quad (9)$$

A study of the sludge left after complete oxidation of the cyanide ion was not undertaken, because at a favorable *p*H value such as 8.5 the volume of the metallic sludge would be about the same as for the first stage of the oxidation. Only if calcium hypochlorite were used would there be more sludge, because of the formation of the very slightly soluble calcium carbonate.

V. *Acid hydrolysis of cyanates*

The acid hydrolysis of cyanates was chosen as a topic for research at a time when it appeared that the rate of oxidation of cyanates by hypochlorites was very low, requiring more than one day to reach completion. This method was selected for speed of reaction and process

TABLE XI. TREATMENT OF POTASSIUM CYANATE SOLUTIONS WITH CALCIUM HYPOCHLORITE

Run No.	Initial KCNO ppm	Initial *p*H Value	Available Cl_2 mole per mole KCNO	Time of Reaction hr	Final KCNO ppm	KCNO Decomposed %	Final *p*H Value	Temp. Rise °C
124	100	7.0	1.0	1.5[1]	49.1	50.9	6.2	<1
125	1,000	9.2	1.0	1.5[1]	294	70.6	6.5	<1
126	10,000	9.6	1.0	1.5[2]	4,430	55.7	7.0	9
127	25,000	9.8	1.0	1.5[2]	8,100	67.7	6.3	20
128	10,000	9.6	1.3	1.25	49	99.5	6.2	10
129	1,000	9.2	1.3	1.5	3.7	99.6	6.95	<1
130	100	7.0	1.3	1.0	<2	100	....	<1
131	100	9.6	1.3	24	<2	100	....	<1

[1]No Cl_2 after reaction
[2]Violent reaction, some Cl_2 after reaction

economy. The acid chosen for this investigation was sulfuric acid. The first few runs (Table XIV) immediately showed that as long as the final *p*H value of the solution was not more than 2.5, the reaction was complete in a very short time (about 5 minutes), and the ratio of reagent to reactant followed the stoichiometry of the reaction represented by equation 7. However, for the case of dilute solutions, such as those containing 500 ppm of cyanate ion or less, it was necessary to add somewhat more than half a mole of sulfuric acid per mole of cyanate in order to lower the *p*H of the solution to within the required value. Thus the sulfuric acid requirement for solutions containing between 50 and 500 ppm of cyanate radical was about 0.9 gal per 100 gal of solution, corresponding to 13.45–1.345 mole of H_2SO_4 per mole of cyanate (31.3–3.13 lb of H_2SO_4 per lb of CNO) to hydrolyze CNO completely in about 5 minutes.

The temperature rise during the reaction in solutions containing less than 5000 ppm of cyanate is very small, and without external heat it is possible to hydrolyze all of the cyanate in less than 15 minutes. It was interesting that whenever solutions containing somewhat over 25,000 ppm of cyanate were treated, a white precipitate formed which was very slightly soluble in water, was hardly dissolved or decomposed by either 50 per cent caustic solution or concentrated sulfuric acid, and was decomposed very slowly in boiling concentrated sulfuric acid. On the basis of this experimental evidence and of information in the literature[9,10], it is believed that this white precipitate is an alkali salt of cyanuric acid. The same type of precipitate was obtained upon treatment of concentrated cyanate solutions with sodium bisulfate (Run 272, Table XV).

This latter compound was chosen for this investigation as an alternate reagent for sulfuric acid because of the ease in handling it and because some small companies might object to the use of sulfuric acid. It was found that the reaction was complete in about 15 minutes if the final *p*H value of the solution was somewhat less than 3, and its stoichiometry was in agreement with the following equation:

$$2NaHSO_4 + KCNO + 2H_2O = (NH_4)HSO_4 + KHSO_4 + Na_2CO_3 \quad (10)$$

two moles of sodium bisulfate being required to hydrolyze one mole of cyanate radical (5.7 lb per lb of CNO). Only for the case of dilute cyanate solutions such as those containing 50 ppm of CNO was it necessary to use at least 5.83 lb of $NaHSO_4$ per 1000 gal of solution and at least 15.0 lb per 1000 gal of solution in order to hydrolyze most of the cyanate in 35 and 15 minutes respectively. These quantities correspond to 14 and 36 lb of $NaHSO_4$ per lb of CNO. In the treatment of concentrated cyanate solutions with sodium bisulfate, the temperature rise is less than in the case of sulfuric acid, because of the smaller heat of solution of sodium bisulfate.

Even with dilute solutions, the reagents requirements become much smaller and closer to the theoretical values if the time of reaction is extended to about one hour. (See Tables XIV and XV.)

Conclusions

I. *Treatment with Hypochlorites*

Cyanides can be oxidized completely

TABLE XII. HYDROLYSIS OF SOLUTIONS OF POTASSIUM CYANATE AT ROOM TEMPERATURE WITHOUT CHEMICAL TREATMENT

Run No.	Orig. KCNO ppm	Time hr	Final KCNO ppm	Initial *p*H Value	Final *p*H Value	KCNO Hydrolyzed %	KCNO Converted to NH_3 %
275	100,000	19	90,200	9.7	9.6	10	4.2
276	50,000	19	48,100	9.6	9.6	3.8	2.1
277	10,000	19	9,950	9.6	9.4	<0.5	0.5
278	1,000	19	970	9.2	9.2	1.5	0.3
279	200	19	200	7.5	7.6	0	0
280	100	19	100	7.0	7.2	0	0
281	50	19	47.5	6.8	7.2	5	<2

TABLE XIII. COMPLETE REMOVAL OF CYANIDE BEYOND THE CYANATE STAGE WITH HYPOCHLORITES AT ROOM TEMPERATURE

Run No.	Type of Cyanide Solution	Initial CN ppm	Type of Reagent Used	Available Cl_2 lb per lb CN	NaOH lb per lb CN	Initial *p*H Value†	Final *p*H Value	Time of Reaction hr	CN Converted into CNO %	CN Completely Destroyed %	Available Cl_2 Reacted lb per lb CN
140	K	100	Cl_2	7.35	6.2	10.45	....	1	9.0	91.0	....
140a	K	100	Cl_2	7.35	6.2	10.45	3.40	0.7	13.5	86.5	....
141	K	100	Cl_2	8.70	10.0	10.45	7.65	0.5	0	100.0	7.21[1]
142	K	100	Cl_2	8.00	10.0	10.45	....	0.25	32.2	67.8	
							9.75	0.50	32.2	67.8	5.28
143	K	100	Cl_2	7.50	10.0	10.45	10.80	0.25	41.0	59.0	
								0.50	41.0	59.0	4.80
144	K	100	NaOCl	8.70	0	10.45	10.85	0.25	94.6	5.4	
								0.50	94.6	5.4	2.93
145	K	100	NaOCl	8.00	0	10.45	11.05	0.25	94.6	5.4	
								0.50	94.6	5.4	2.86
146	K	100	NaOCl	7.50	0	10.45	10.90	0.25	94.6	5.4	
								0.50	94.6	5.4	2.83
147	K	100	Cl_2	8.70	10	8.60[2]	8.60[2]	0.25	12.0	88.0	
								0.50	3.6	96.4	7.47[1]
148	K	100	NaOCl	8.70	0	8.60[2]	8.60[2]	0.25	9.5	90.5	
								0.50	3.1	96.9	7.06[1]
149	Na	200	NaOCl	8.70	0	11.55[2]	11.55[2]	0.50	85.75	14.25	
								1.00	85.75	14.25	2.95
150	Na	200	NaOCl	8.70	0	11.30[2]	11.30[2]	0.50	85.8	14.2	
								1.00	85.8	14.2	2.95
151	Na	200	NaOCl	8.70	0	10.95[2]	10.95[2]	1.00	85.8	14.2	3.30
152	Na	200	NaOCl	8.70	0	10.20[2]	10.20[2]	0.50	48.0	52.0	
								1.00	23.2	76.8	....
153	Na	200	NaOCl	8.70	0	9.25[2]	9.25[2]	0.50	3.1	90.6	
								1.00	0	100	7.30[1]
154	Na	200	NaOCl	8.70	0	9.65[2]	9.65[2]	0.50	38.0	62.0	5.96
155	Na	200	NaOCl	8.70	0	9.45[2]	9.45[2]	0.50	29.6	69.4	
									9.3	90.7	6.90[1]
156	Na	200	NaOCl	8.70	0	8.95[2]	8.95[2]	0.50	0	100.0	
								1.00	0	100.0	7.47[1]
157	Na	200	NaOCl	8.70	0	8.90[2]	8.90[2]	0.50	0	100.0	
								1.00	0	100.0	7.31[1]
158	Na	200	NaOCl	8.70	0	8.85[2]	8.85[2]	0.50	0	100.0	
								1.00	0	100.0	7.45[1]
159	Na	200	NaOCl	8.40	0	8.70[2]	8.70[2]	1.00	1.1	98.9	7.50[1]
160	Na	200	NaOCl	8.08	0	8.70[2]	8.70[2]	1.00	1.8	98.2	7.60[1]
161	Na	200	NaOCl	7.77	0	8.70[2]	8.70[2]	1.00	2.2	97.8	7.30[1]
162	Na	200	NaOCl	7.45	0	8.70[2]	8.70[2]	1.00	4.1	95.9	7.32[1]
163	Na	200	NaOCl	7.15	0	8.70[2]	8.70[2]	1.00	7.7	92.3	7.32[1]
167	Na-Cu	1000[3]	NaOCl	6.84	0	9.40[2]	9.40[2]	0.75	47.5	52.5	6.66[1]
168	Na-Cu	100[3]	NaOCl	6.85	0	9.40[2]	9.40[2]	0.75	55.0	45.0	6.79[1]

TABLE XIII

(Continued)

Run No.	Type of Cyanide Solution	Initial CN ppm	Type of Reagent Used	Available Cl_2 lb per lb CN	NaOH lb per lb CN	Initial *p*H Value†	Final *p*H Value	Time of Reaction hr	CN Converted into CNO %	CN Completely Destroyed %	Available Cl_2 Reacted lb per lb CN
169	Na-Zn	1000[8]	NaOCl	5.15	0	11.60[2]	11.40[2]	0.75	96.0	4.0	3.08
170	Na-Zn	100[8]	NaOCl	6.16	0	8.65[2]	8.65[2]	0.75	64.8	35.2	4.57
171	Na-Cu	100[9]	NaOCl	8.30	0	8.35[3]	8.35[3]	1.00	4.9	95.1	7.47[1]
172	Na-Cu	100[9]	NaOCl	8.30	0	8.35[3]	8.35[3]	1.00	4.9	95.1	7.47[1]
173	Na-Zn	100[8]	NaOCl	8.30	0	8.65[3]	8.65[3]	1.00	4.9	95.1	7.33[1]
174	Na-Zn	100[8]	NaOCl	8.30	0	8.65[3]	8.65[3]	1.00	4.9	95.1	7.31[1]
177	Na-Cu	400[5]	NaOCl	8.70	0	8.80[3]	8.80[3]	1.00	0.7	99.3	7.60[1]
178	Na-Zn	400[6]	NaOCl	8.70	0	9.30[3]	9.30[3]	1.00	0.7	99.3	7.42[1]
183	Na	100	NaOCl	8.18	0	9.20[3]	9.20[3]	0.50	44.1	55.9	
								1.00	37.2	62.8	7.88[1]
184	Na	100	NaOCl	8.18	0	9.00[3]	9.00[3]	0.50	14.7	85.3	
								1.00	8.2	91.8	7.88[1]
185	Na	100	NaOCl	8.18	0	8.80[3]	8.80[3]	0.50	10.2	89.8	
								1.00	6.7	93.3	7.98[1]
186	Na	100	NaOCl	8.18	0	11.20	10.95	0.50	96.0	4.0	
								1.00	94.5	5.5	....
188	Na	100	NaOCl	8.18	0	8.35[4]	8.35[4]	0.50	6.1	93.9	
								1.00	5.0	95.0	7.73[1]
189	Na	100	NaOCl	8.18	0	7.70[4]	7.70[4]	0.50	5.0	95.0	
								1.00	1.9	98.1	8.09[1]
190	Na	100	NaOCl	8.18	0	7.25[4]	7.25[4]	0.50	6.3	93.7	
								1.00	3.8	95.2	7.94[1]
179	Na-Zn[7]	400[8]	NaOCl	8.70	0	9.60[2]	9.60[2]	1.00	7.0	93.0	8.00[1]
180	Na-Cu[7]	400[9]	NaOCl	8.70	0	8.80[3]	8.80[3]	1.00	0.7	99.3	8.20[1]
181	Brass[7]	400[10]	NaOCl	8.70	0	8.80[3]	8.80[3]	1.00	5.7	94.3	....
182	Na-Cd[7]	400[11]	NaOCl	8.70	0	9.25[3]	9.25[3]	1.00	6.8	93.2	8.52[1]

*Amount of added NaOH; does not include alkali already present in metallo-cyanide solutions or NaOH added in buffer solution.

†Measured before the addition of hypochlorite reagent

[1]Reagent requirements calculated after residual Cl_2 had been determined.

[2]NaOH–H_3BO_3, [3]$NaHCO_3$, [4]NaOH–KH_2PO_4 buffer solution

[5]64.7 parts Cu, [6]63.5 parts Zn per 100 parts CN

[7]Obtained by dilution of commercial electroplating solutions

[8–11]Nitrogenous matter originally present in solution as [8]80, [9]96, [10]160, [11]144 ppm $(NH_4)_2SO_4$

(to less than 0.2 ppm of CN) to cyanates by hypochlorites* in less than five minutes at room temperature. Only cyanide solutions containing divalent nickel were found to require a longer time of reaction, namely about one-half hour. Furthermore, in the latter case the excess reagent used should be at least 20 per cent in order to insure complete oxidation of the cyanide in about one-half hour, whereas in other cyanide solutions a very slight excess is necessary to insure complete oxidation of cyanide to cyanate.

Cyanates can be completely destroyed (to less than 1 ppm of CNO) by oxidation to carbon dioxide and nitrogen at room temperature in about one hour. Whereas the oxidation of cyanides to cyanates should be carried out preferably within a *p*H range of about 10–12.5 to eliminate the presence of toxic quantities of cyanogen chloride, it is preferred that the oxidation of cyanates be carried out at a *p*H between 7.5 and 9. *Some of our experimental work has given indication that the oxidation of cyanates by hypochlorites is very rapid (less than 5 minutes) at slightly acidic pH values (6.0–6.5).* As the *p*H value is increased beyond 9, the rate of oxidation of cyanate by hypochlorites decreases rapidly. At *p*H values above 11, the reaction is slow and may require many hours to reach completion.

Cyanogen chloride, which is the intermediate product of the oxidation of cyanides to cyanates by hypochlorites, is very toxic and hydrolyzes very slowly below a *p*H value of 9. The rate of hydrolysis decreases rapidly as the *p*H value of the treated solution decreases, so that, depending on the *p*H, the time for complete disappearance of the cyanogen chloride

*By hypochlorite is meant a reagent which upon dissolving in water will make available the hypochlorite ion. The following reagents were used: chlorine, sodium hypochlorite, and calcium hypochlorite.

TABLE XIV. HYDROLYSIS OF ALKALI CYANATES WITH SULFURIC ACID AT ROOM TEMPERATURE

Run No.	Orig. KCNO ppm	H_2SO_4 mole per mole CNO	H_2SO_4 gal per 1000 gal solution	Temp. Rise °C	Initial *p*H Value	Final *p*H Value	Time of Reaction min	CNO Converted to $(NH_4)_2SO_4$ %
255	100,000	0.5	68	33[1]	10.5	<1	60	55.1
256	10,000	0.5	6.8	3	9.5	....	60	95.5
257	1,000	0.5	0.68	<1	9.2	....	60	100.0
258	100	0.667	0.091	<1	7.0	2.15	60	98.4
259	100	1.334	0.182	<1	7.0	....	5	51.5
261	100	4.0	0.545	<1	7.0	2.4	5	76.2
262	100	6.67	0.91	<1	7.0	<2	5	98.4
263	100	13.34	1.82	<1	7.0	<2	5	100.0
264	100,000	0.133	1.82	20[1]	10.5	7.4	60	6.8
						10.1	1200[2]	
265	50,000	0.133	9.1	7	10.1	5.75	5	
						6.75	60	9.1
						9.75	1200[2]	
266	10,000	0.2	1.7	<1	9.6	6.15	5	
						....	60	36.2
						8.75	1200	
267	1,000	0.5	0.68	<1	9.2	2.65	60	99.5
268	100	3.33	0.452	<1	7.0	2.8	60	90.5

[1]Violent frothing. White precipitate formed containing nitrogenous matter.
[2]Strong ammonia odor after 20 hours

may vary between a few minutes and a few hours. However, even at low alkaline *p*H values, the rate of hydrolysis may be increased greatly by addition of excess hypochlorite. The larger the excess, the faster is the disappearance of cyanogen chloride. Therefore, if the oxidation is carried beyond the cyanate stage, there is no need for concern, because the excess hypochlorite would be more than enough to destroy the cyanogen chloride in less than five minutes.

The formation of toxic and explosive nitrogen trichloride is unlikely if cyanides or cyanates are oxidized at a *p*H above 6.

The reagent requirements which apply to cyanide solutions, whether or not they contain oxidizable metallic ions, are as follows:

Oxidation of cyanide to cyanate—
2.73 lb of available Cl_2 per lb of CN and 3.08 lb of NaOH per lb of CN

Oxidation of cyanide to CO_2 and N_2—
7.3–7.6 lb of available Cl_2 per lb of CN and 6.6–6.8 lb of NaOH per lb of CN

These are stoichiometric requirements. Sometimes in order to accelerate a reaction it is necessary to add excess reagent. Thus, in order to oxidize cyanates to completion in one hour or somewhat less it is necessary to add not less than 10–15 per cent excess hypochlorite reagent (Fig. 7). After the reaction has been completed any excess reagent can be rapidly reduced with sodium sulfite or thiosulfate.

If there is cuprous ion in solution, additonal hypochlorite should be used corresponding to 0.56 lb of available Cl_2 per lb of cuprous copper. If there is nickelous ion in solution, the additional hypochlorite requirements become 2.12–2.24 lb of available chlorine per lb of nickelous ion.

The amounts of sodium hydroxide shown above represent total hydroxide requirements when elemental chlorine is used for the oxidation of cyanide solutions which do not contain added hydroxide or carbonate. Although no experimental work was done with other alkaline reagents, it is expected that equivalent amounts of either sodium carbonate or calcium hydroxide could be substituted for the caustic soda.

When sodium hypochlorite is used as the oxidizing agent, there is no need to add sodium hydroxide. Actually, to accelerate the second stage of the oxidation, that of cyanate to carbon dioxide and nitrogen, it is necessary to neutralize the solution with sodium bicarbonate or with an acid to lower the *p*H value of the solution to within the prescribed limits (7.5–9). If commercial calcium hypochlorite is used as the oxidizing agent, the amount of sodium hydroxide to be added, if any, is considerably smaller than that required when elemental chlorine is employed.

If the solution to be treated already contains some added hydroxide or carbonate, provisions should be made that only the amount of base be added corresponding to the difference between the total requirements and that which is already present.

The treatment of cyanides with commercial calcium hypochlorite causes the formation of more sludge than the treatment with either chlorine or sodium hypochlorite. It is therefore suggested that the commercial calcium hypochlorite, when added as a solid, be used only to treat cyanide solutions with a total cyanide (CN) content of less than 5000 ppm. It may be used for treatment of more highly concentrated solutions if it is added in the form of a clear aqueous solution.

In the treatment of cyanide electroplating solutions it is necessary to remove not only the cyanide but also the heavy metals which are also toxic to organisms. Therefore, if the particular cyanide treatment does not eliminate these heavy metals almost completely from the supernatant liquid, some other additional treatment is necessary.

In the oxidation of cyanides to cyanates in an electroplating solution by use of the hypochlorite ion, the *p*H value of the treated solution is usually high enough to keep in solution appreciable quantities of heavy metals which are amphoteric. Cop-

TABLE XV. HYDROLYSIS OF ALKALI CYANATES WITH SODIUM BISULFATE AT ROOM TEMPERATURE

Run No.	Orig. KCNO ppm	$NaHSO_4$ moles per mole CNO	$NaHSO_4$ lb per 1000 gal solution	Temp. Rise °C	Initial *p*H Value	Final *p*H Value	Time of Reaction min	KCNO Hydrolyzed %
269	10,000	1.02	126	<2	9.5	4.1	60	39.5
							120	39.5
270	10,000	1.31	162	<2	9.5	3.6	60	52.6
271	10,000	2.00	247	<2	9.5	3.15	25	100.0
272	100,000	2.00	2470	12[1]	10.5	2.85	60	65.5
273	50,000	2.00	1235	6	10.1	3.3	15	92.5
							60	94.3
274	10,000	2.00	247	<2	9.5	....	15	87.0
						3.7	60	90.6
275	1,000	2.00	24.7	<1	9.2	....	15	36.0
						4.15	60	89.1
276	100	4.50	5.55	<1	7.0	4.15	15	100.0
							60	100.0
280	100	4.00	1.67	<1	7.0	4.15	5	31.0
							35	66.0
281	100	6.00	2.50	<1	7.0	3.60	5	36.0
							35	86.0
282	97	8.00	3.33	<1	7.0	3.20	5	38.0
							35	89.0
283	97	10.00	4.16	<1	7.0	2.95	5	39.0
							35	92.5
284	97	12.00	5.00	<1	7.0	2.80	5	39.0
							35	96.0
285	97	14.00	5.83	<1	7.0	2.65	5	39.0
							35	101.5
286	97	16.00	6.67	<1	7.0	2.65	5	58.0
							15	91.0
287	97	20.00	8.33	<1	7.0	2.50	5	59.0
							15	92.5
288	97	24.00	10.00	<1	7.0	2.45	5	61.5
							15	92.5
289	97	28.00	11.65	<1	7.0	2.40	5	59.0
							15	93.5
290	97	32.00	13.30	<1	7.0	2.35	5	61.5
							15	96.0
291	97	36.00	15.00	<1	7.0	2.30	5	61.5
							15	95.5
292	97	60.00	25.00	<1	7.0	2.00	5	75.0
							15	99.0
293	97	120.00	50.00	<1	7.0	1.85	5	99.8
							15	100.0

[1]Violent bubbling. Formation of white precipitate containing nitrogenous matter.

TABLE XVI. ANALYSIS OF CYANIDE SOLUTIONS WITH SODIUM HYPOCHLORITE

Run No.	Type of Solution	Actual Cyanide ppm	Calc'd Cyanide ppm	Cl_2 Demand lb per lb CN
1	Synthetic Cu plating	48,900	48,400	3.06
2	Comm. Cd plating	57,000	55,000	3.04
3	Comm. Brass plating	33,000	34,500	2.86
4	Comm. Cu plating	48,000	48,500	2.76
5	Comm. Zn plating	59,600	63,300	2.90
6	Pure sodium cyanide	5,600	5,630	2.75
7	NaCN + 120 ppm $AgNO_3$	5,600	5,600	2.73
8	NaCN + 1040 ppm $AgNO_3$	5,600	5,580	2.70
9	Silver waste mixed with liquid from sanitary sewer	5.32	21.6	11.10
		2.02	2.4	3.22
10	Silver waste mixed with liquid from sanitary sewer	44.5	106.0	6.50
		48.5	69.5	3.92
11	Plated out silver plating waste	2460	4400	4.88
		2380	3980	4.56

per does not present any problem because most of the copper precipitates at the *p*H value used for oxidation of cyanides, leaving only 1.5 ppm of copper ion in solution. Cadmium also would be expected to precipitate almost completely. Zinc, however, being very soluble in water at highly alkaline *p*H values, should be removed from the supernatant liquid either by further chemical treatment, i. e., by addition of bicarbonates in order to neutralize the hydroxyl ions, thus precipitating zinc carbonate and leaving 4–5 ppm of zinc in the supernatant liquid, or by diluting the treated solution until its *p*H value is somewhat below 9. If the oxidation of cyanide is carried through the cyanate stage, the zinc will precipitate as a carbonate, and there is no need for addition of bicarbonate.

After treatment of cyanide[e] with hypochlorites, a quick test for absence of cyanide may be performed by determining qualitatively if free chlorine is present. Methods such as the ortho-tolidine-arsenite test or the potassium-iodide-starch test may be used. The presence of any excess chlorine will usually indicate that the cyanide has been completely converted to cyanate[e], whether such heavy metals as zinc, copper and cadmium are present or not, because of the rapidity of the reaction.

However, this test is not considered valid if metallic nickel is present in solution, because the presence of excess chlorine does not indicate that all of the cyanide has been removed, in view of the slowness of the cyanide-to-cyanate reaction in the presence of nickel. A qualitative test for free chlorine is also inadvisable to indicate that all of the cyanate has been oxidized, because the oxidation of cyanate may require anywhere from five minutes to more than one hour, depending upon the conditions chosen. In both of these cases it is preferable to determine quantitatively the amount of chlorine left in solution. The amount of residual cyanide or cyanate can then be calculated on the basis of the stoichiometry of the reaction. A quick quantitative method of analysis consists in titrating the solution iodometrically with a standard solution of sodium thiosulfate.

II. *Elimination of cyanates by acid hydrolysis*

Cyanates may be completely converted into ammonium salts by acid hydrolysis in about five minutes and without the use of external heat. The reactions should be conducted at *p*H values in the range from 2 to 3. At higher *p*H values the rate of hydrolysis decreases. Both concentrated sulfuric acid and solid sodium bisulfate were used for these investigations. It was found that the reagent requirements for complete hydrolysis of the cyanates were 1.17 lb of H_2SO_4 per lb of CNO or 5.72 lb of $NaHSO_4$ per lb of CNO, except for solutions containing less than 500 ppm of CNO, in which the amount of reagent used was not enough to lower the *p*H value of the treated solution to within the prescribed limits. Thus solutions containing 59 ppm of CNO were found to require for complete hydrolysis of cyanates in about 5 minutes 0.9 gal of concentrated sulfuric acid or 50 lb of $NaHSO_4$ per 1000 gal of solution (31.3 lb of H_2SO_4 or 120 lb of $NaHSO_4$ per lb of CNO).

ACKNOWLEDGMENT

We wish to acknowledge the courtesy of the Electrochemicals Department of the E. I. duPont de Nemours & Co. in permitting us to make use of material in certain unpublished progress reportsdealing with the disposal of waste cyanide.

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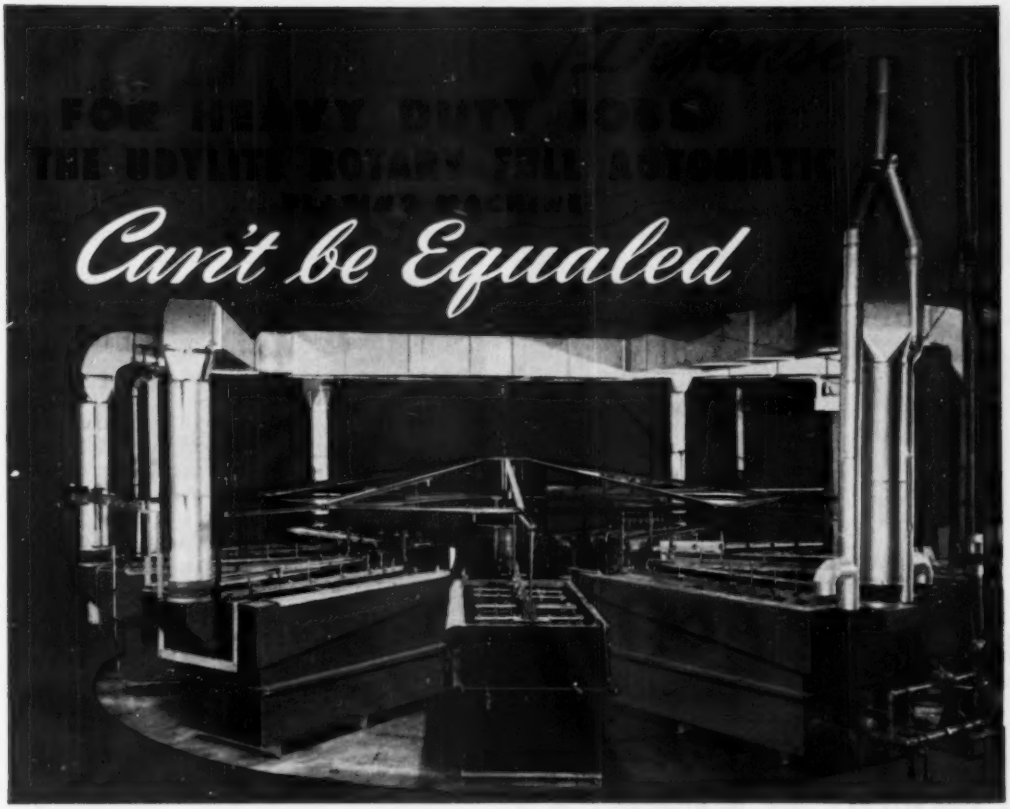
[e]This is true if the solution is agitated so thoroughly that the reagent either dissolves or becomes uniformly dispersed immediately after having been added.



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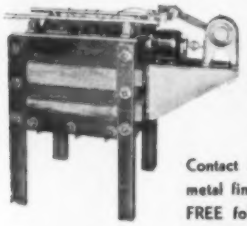

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Q. 115. Not having any nickel with which to plate over copper, we have tried to chromium plate directly over the copper but have run into difficulties with coverage. Buffed copper plate is placed on a full automatic, cleaned thoroughly and acid dipped, flashed in a cyanide-copper bath, then passed through a 1 per cent by volume sulfuric acid solution in the old nickel tank to keep the copper active. What can you recommend?

A. Your trouble is likely to be slight passivity of the copper. If you have a rubber-covered nickel-dragout tank, it can be used to hold an activating dip composed of 3–5 per cent by volume sulfuric acid with 0.2–0.4 oz/gal potassium iodide and 0.01–0.02 oz/gal of free iodine. The latter can be added as iodine crystals or can be formed in the tank by cautious addition of weak chromic acid-dragout solution. In either case the final solution should have a light coffee color. It is active as long as the color persists. After thorough rinsing, the parts are then transferred into the chromium solution. The 53 oz/gal solution is satisfactory and preferred to the 33 oz/gal solution.

Another difficulty may be etching of the copper in the chromium bath. To overcome this, the conveyor should be changed, if necessary, so that current can be applied as soon as the rack is fully immersed. Current should not be on while the work enters the solution, nor should there be any delay in applying the current after immersion is complete.—H. L. PINKERTON.

Q. 116. In trying to silver plate both the inside and outside of soft-metal coffee pots I have found that if I plate the inside first, the inside plate strips off when I plate the outside, and if I reverse the order, the outside plate gets rough. What should I do?

A. Your best bet is to plate both simultaneously. You will need two separate anode circuits to control the plating, each with an ammeter and a rheostat. The tank rheostat with its ammeter will serve for the outside plating, and separate line will have to be supplied for the inside plating. Because you probably strike with copper before you silver strike and silver plate, and because soluble-metal anodes of the small size required for inside plating are likely to become inactive rather quickly, you would probably do best with an insoluble anode of steel or nickel.—K. G. SODERBERG.

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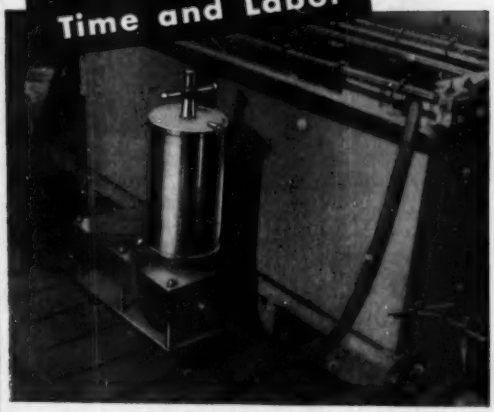

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No. 2,534,234, December 19, 1950—Electrocoating Method—G. C. Cox.

It is an object of my invention to provide a novel method for producing a corrosion-resistant binary coating of substantially uniform thickness . . . dielectric coatings upon objects such as wires, rods, plates, metal foils and the like . . . two-component corrosion-resistant coating of a nonmetallic nature upon metallic surfaces, one component of which is crystalline and one amorphous . . . which may be hardened in an extremely short period of time.

CLAIM 7. The process of producing a protective coating on a metal surface which comprises the steps of immersing that part of the surface to be coated in an electrolyte, maintaining said part of the metal surface cathodic, maintaining the cathode current density greater than 0.4 ampere per square foot, maintaining said electrolyte to consist of an aqueous solution having as the essential plating components magnesium and calcium ions in sufficient quantities for plating action to occur, maintaining the *p*H factor of said electrolyte . . . between the limits of 4.0 to 9.5, and maintaining the temperature of the electrolyte below the boiling point under the operating conditions and within the range expressed by the equation

$$T = 34 \log_{10} X + 30 \text{ and } T = 34 \log_{10} X + 70$$

where T is temperature in degrees centigrade and X is the cathode current density in amperes per square foot.

7 claims, 5 figures.

References cited: U. S. Patent 872,759; 2,200,469. British Patent 6,495.

No. 2,540,175, February 6, 1951—Manufacture by Electrodeposition—G. Rosenqvist.

CLAIM 7. In apparatus for making seamless tubing by galvanic process, a storage tank for the electrolytic solution, a working tank mounted adjacent the solution tank, a cathode in the shape of a relatively long cylindrical rod journalled for rotation in the working tank, perforated walls in the working tank constituting supports for anode material arranged to space said material equidistant from said cathode, means for connecting the anode material inside the tank with a source of current, impact mechanism comprising a carriage having a plurality of supports movable above the working tank, a plurality of reciprocating elements mounted for sliding movement in said supports in alignment with the cathode means for maintaining said reciprocating elements out of contact with said cathode when inoperative, means for subjecting said elements

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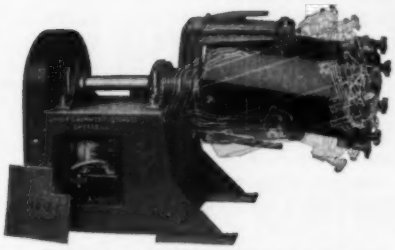

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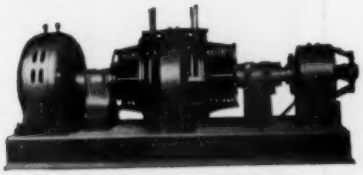

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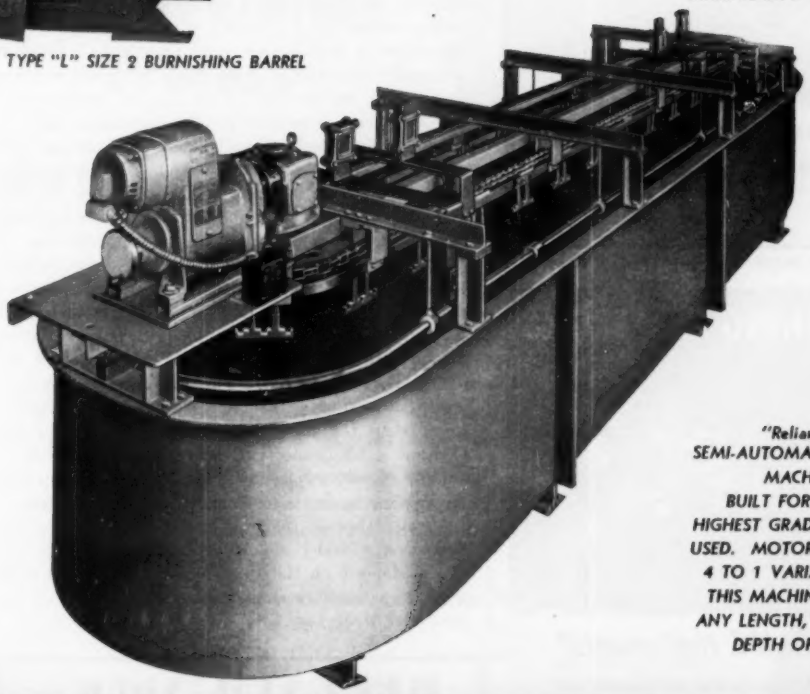

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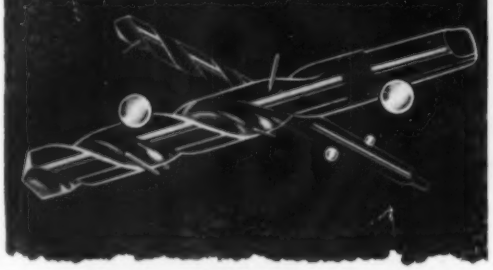

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to rapid reciprocatory movement to effect momentary impact contact with the deposited material on said cathode, and means for slowly moving said carriage axially of said cathode in one direction and for rapidly returning said carriage to its initial starting position when it has reached the limit of its travel.

30 claims, 29 figures.

References cited: U. S. Patents 2,061,554; 2,164,380; 2,199,602; 2,203,253; 2,405,776. British Patent 11,778; 18,516. Swiss Patent 23,931. Metal Ind. (N. Y.) **28**, 378–380 (August, 1930).

No. 2,540,805, February 6, 1951—Electrolytic Apparatus for Making Radiator Cores—J. D. Beebe, assignor to John C. Schwartz, New York, N. Y.

CLAIM 4. An electrolytic apparatus for making a radiator core comprising a matrix formed in the shape of the core, having a plurality of openings transversely therethrough and having solid projections extending outwardly therefrom in replication of the hollow water connections of the core, said matrix serving as a cathode when immersed in an electrolyte, and an anode residing alongside each side of said matrix, each of the anodes being a container for electrolytic metal and each having a multiplicity of hollow tubular projections extending laterally therefrom, each of said extensions terminating immediately opposite one of said openings, said anodes each having a multiplicity of additional openings through the walls thereof through which ions may flow for deposit on the boundary surfaces of said matrix, said anodes each presenting a solid surface opposite said solid projections of the matrix and each having a ring-like extension thereon the inside surface of which is similar to and slightly larger than the periphery of the outer end of the adjacent solid connection, said ring-like projections residing closely adjacent said solid projections, said anodes each having a multiplicity of openings through the walls thereof together encircling said ring like extensions whereby a flow of ions therethrough will form a deposit on the exposed surfaces of said solid projections simultaneously with the formation of the remainder of the core.

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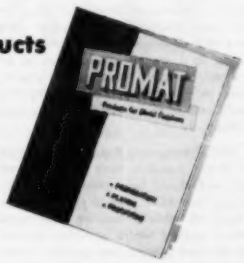

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Patent Abstracts

4 claims, 6 figures.

References cited: U. S. Patents 895,164; 1,188,228; 1,280,249; 1,416,929; 1,517,630; 1,519,572; 1,765,320; 1,792,998; 1,853,700; 2,260,893.

No. 2,541,083, February 13, 1951—Electroplating on Aluminum—Edward B. McDermott, assignor to The Sperry Corporation.

CLAIM 1. The method of plating aluminum alloys which consists of the step of producing a surface of substantially pure aluminum on the article to be plated by pickling in a nitric-hydrofluoric acid dip of 90 per cent to 99 per cent of concentrated nitric acid (67 per cent) with the balance of concentrated hydrofluoric acid (48 per cent), the dip being proportioned in accordance with the type of alloy selectively to dissolve associated alloying ingredients from the surface of the article while the hydrofluoric acid is present in an amount insufficient to cause the evolution of gas, then anodizing the article in a sodium carbonate solution by alternating current, and thereafter electroplating the anodized surface of the article.

CLAIM 2. . . . then anodically oxidizing the surface of the article under the influence of an alternating current in a sodium carbonate solution, whereby the oxide is formed only during half-wave periods while the surface of the article is continuously attacked by the solution resulting in the formation of an oxide film, and thereafter electroplating over the film.

2 claims.

References cited: U. S. Patents 1,147,718; 1,387,426; 1,405,534; 1,935,395; 1,947,981; 1,968,483; 1,971,761; 1,988,645; 2,137,988; 2,222,398; 2,233,785; 2,256,860; 2,287,111; 2,313,756; 2,347,742; 2,399,134. Harold Work, "Electroplating on Aluminum and Its Alloys," Metal Ind. (London) **33**, 81–84 (July 27, 1928). J. Franklin Inst. **144**, 187 (September, 1897).

No. 2,541,597, February 13, 1951—Electroplating Rack—K. R. Midling, assignor to Plomb Tool Company, Los Angeles, Calif.

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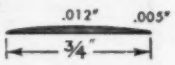

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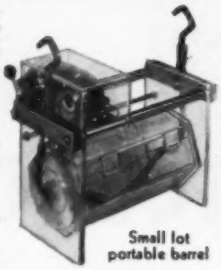

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Patent Abstracts

CLAIM 1. An electrically conductive electroplating rack comprising a pair of parallel vertical supporting rails, electrically conductive transverse bars connecting said rails, the front edges of said rails being provided with article-receiving and -engaging notches, said notches in the two rails being located in lateral alignment, so as to form article-engaging pairs of notches between said bars, and article-engaging spring arms mounted on and extending upwardly from said transverse bars between said rails, each of said spring arms reaching upwardly to the pair of notches next above, and said arms being shaped and arranged to engage and exert holding pressure against articles placed in said pair of notches.

3 claims, 11 figures.

References cited: U. S. Patents 384,806; 1,010,638; 2,108,978; 2,346,386. German Patent 549,777.

No. 2,541,721, February 13, 1951—Process for Replenishing Nickel Plating Electrolyte—E. J. Roehl and Andrew Wesley, assignors to The International Nickel Company.

It has been recognized in the art that insoluble anode processes for electroplating nickel offers distinct advantages in many fields. For example, in the plating of steel strip and wire, the electroforming of fine screen material and parts of intricate or irregular shape, plating the inside of tubes, etc., it is important that the distance separating anode from cathode be kept substantially constant, and this is most readily accomplished by employing anodes which are substantially insoluble in the plating bath.

It is an object of the present invention to provide a process for electrodepositing nickel from a cell having an insoluble anode wherein the nickel content and *p*H of the electrolyte are maintained substantially constant.

CLAIM 6. The process for electrodepositing nickel which comprises establishing an aqueous nickel plating electrolyte essentially comprised of about 100 to 400 grams per liter of nickel sulfate, about 10 to 50 grams per liter of boric acid, substantially devoid of

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Patent Abstracts

chloride ions, having a *p*H of about 0.75 to 3.5 and a temperature of about 100 to 160° F, electrodepositing nickel from said electrolyte in an electroplating unit having a source of direct current, at least one insoluble anode and at least one cathode by passing a plating current from said direct-current source through said electrolyte from said insoluble anode to said cathode to electrodeposit nickel at said cathode, flowing said electrolyte to a replenishing unit comprising a source of reversible direct current in electrical connection with a plurality of electrolytic-nickel electrodes, substantially replenishing the nickel content of said plating electrolyte by passing therethrough between said electrodes direct current from said source of reversible direct current at a current density of about 1 to 25 amperes per square foot while repeatedly reversing the direction of said direct current at time intervals of about 1 to 50 seconds to obtain a net gain of nickel dissolved from said electrodes, flowing the thus-replenished electrolyte to an electroplating unit and electrodepositing nickel from the thus-replenished electrolyte.

11 claims, 1 figure.

References cited: U. S. Patents 1,003,092; 1,144,680; 1,885,148; 2,431,949; 2,449,422; 2,449,495; 2,451,341; 2,470,775. British Patent 310,099. Danish Patent 49,384. O. P. Watts, Trans. Electrochem. Soc. **59,** 381 (1931). Blum *et al.*, Trans. Faraday Soc. **31,** 1208 (1935). Finch *et al.*, ibid. **33,** 566 (1937).

No. 2,542,112, February 20, 1951—Method of Regenerating Aluminum Anodizing Solution—Oscar R. Borngesser, assignor to Boeing Airplane Company.

CLAIM 1. The continuous regeneration process which comprises electrolyzing partially spent aluminum-anodizing chromic acid electrolyte in a regenerating unit which separates the anolyte and the catholyte by a porous partition, by such electrolyzing increasing the chromic acid content of the anolyte to decrease its *p*H, and forming aluminum hydroxyl compound in the catholyte, some as precipitate and some in solution, accompanied by an increase in the *p*H of the catholyte,

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1—300 amp., 25 volt, 1750 RPM., type SK-110L Westgh. generator with AC motor.
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continually withdrawing catholyte and precipitate contained therein, continually withdrawing anolyte for reuse as anodizing electrolyte, and continually supplying partially spent anodizing electrolyte to the regenerating unit to compensate for such withdrawal of catholyte and anolyte.

CLAIM 2. . . . increasing the *p*H of the catholyte to . . . about 3.3 and decreasing the *p*H of the anolyte to . . . about 0.6 . . .

5 claims, 2 figures.

References cited: U. S. Patents 675,749; 1,371,698; 1,382,808; 1,408,618; 1,986,920; 1,990,582; 2,055,962; 2,081,787; 2,085,002; 2,099,658; 2,333,578. British Patent 22,819. J. Ind. Eng. Chem. **12**, 16–26 (January, 1920). Plating, Polishing, Finishing 29–31 (February, 1932).

No. 2,545,294, March 13, 1951—Anode Control for Plating Tanks—W. Messinger and D. B. Lytle, assignors to Time, Incorporated, New York, N. Y.

CLAIM. A tank for plating elongated cylinders comprising an elongated vertically disposed tank structure for containing an electrolyte and an elongated cylinder, a vertically disposed bay extending outwardly of and opening into the tank at one side thereof, an anode in the bay, means for adjusting the position of the anode in the bay, a door between the bay and the tank, a well in the bottom of the tank, a plate mounted for rotation in the well, and a bearing mounted on the plate for eccentric rotation with reference to the plate and for receiving one end of an elongated cylinder, the door being supported for rotation about a vertical axis to vary the effective width of the entrance into the bay during a plating operation and thereby control the current density under varying conditions of temperature in the electrolyte, the plate in the well being rotatable to adjust the distance between the anode and the cylinder to be plated, and the cylinder-supporting bearing being rotatable relative to the plate for rotating the cylinder within the tank during the plating operation.

1 claim, 5 figures.

References cited: U. S. Patents 680,408; 1,519,572; 2,086,226; 2,155,392. French Patent 712,505.

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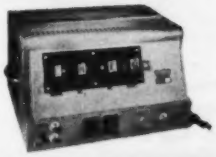

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The time for the Buffalo Convention is now approaching rapidly. Because it falls at the height of the vacation period, many platers are expected who do not usually have the opportunity to take part in Convention activities. The area around Buffalo is a vacation land par excellence, and many will bring their families and remain in the neighborhood throughout their vacation period.

Buffalo is also only a short distance away from Niagara Falls, giving Convention visitors and wives an opportunity to spend some time at this honeymooners' heaven, perhaps for the first time, making up for a previously lost chance, or perhaps to recall pleasant memories of the past.

The Buffalo Branch is doing a magnificent job on short notice in arranging to welcome the members of the A. E. S. and other visitors. The two pictures shown here introduce the Convention hosts. At the top, front row, are, left to right: James Moneypenny (Banquet and Entertainment Chairman), Dr. C. J. Wernlund (Educational Chairman), Mrs. Joan Wiarda (Publicity Chairman), Bill Fotheringham (General Co-chairman and Reception Chairman), Bert Kirchhoff (General Chairman), Anthony Nigro (House Chairman), Leon Nowak (Transportation Chairman), Ben Fortin (Hotel Reservations Chairman), H. A. Fudeman (Program Chairman); rear row: Roland Campbell, Robert Potter, Harold Day, Frank Nowakowski, Simon Bush, Don Rice, Ward Stewart, Bill Hart (Registration Chairman), Joe Ruff (Entertainment and Outing Chairman), Joe Cuerdon, T. W. Rudolph.

In the bottom picture we introduce the Ladies' Committee. From left to right: Mrs. H. A. Fudeman, Mrs. Joan Wiarda, Mrs. Bert Kirchhoff, Mrs. Frank Nowakowski, Mrs. Roland Campbell, Mrs. William Hart, Mrs. James Moneypenny, Mrs. Anthony Nigro (Chairman), Mrs. Ben Fortin, Mrs. Robert Potter, Mrs. Leon Nowak, Mrs. Stan Sharmen, Mrs. C. J. Wernlund.

Come to Buffalo! If you have not already made your reservation, wait no longer. Send your reservation form, or if you have lost yours, copy the one found on page 346 of the April issue and send it, to Mrs. Mary E. Brock, Manager, Housing Bureau, 602 Genesee Building, Buffalo 2, N. Y.

A. E. S. News

The Transfer of the 1951 Convention From Los Angeles to Buffalo

Some members have wondered exactly why the 1951 Convention was transferred from Los Angeles to Buffalo.

The reason was simply that only a few members could see their way clear to take the time and spend the money involved in a trip across the continent. Undoubtedly the heavy work load imposed by the rearmament program and the reduced income of those still on civilian work were the determining factors.

The effect of this situation was twofold. On one hand, a Convention in Los Angeles would not fulfill its purpose of bringing platers together to discuss mutual problems, so desirable at this time. On the other hand, it takes a great deal of money to run a Convention, whether it be attended by many or few, and the Society stood to lose many thousand dollars.

It is to the credit of the Los Angeles Branch, which had expended so much effort on the undertaking, that it decided to put the welfare of the Society ahead of the satisfaction of being the Convention host.

New Sustaining Members

Again we have the pleasure of announcing additions to the sustaining membership list, as follows:

Accurate Engineering Laboratories, Chicago, Ill.
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American Fixture & Manufacturing Company, St. Louis, Mo.
Hardwood Line Manufacturing Company, Chicago, Ill.
A. J. Lynch & Company, Los Angeles, Calif.
J. P. Seeburg Corporation, Chicago, Ill.
Sparkler Manufacturing Co., Mundelein, Ill.
S. K. Williams Company, Milwaukee, Wis.

Credit goes to these firms for deciding to support effectively the important work of the A. E. S. Research Committee, as well as to the Chicago, Los Angeles, Milwaukee and St. Louis Branches and their Research Finance Committees for their successful sales efforts.

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Branch News

BALTIMORE-WASHINGTON BRANCH

On March 20 we were treated to a very interesting talk by MR. R. W. COOK of Brush Development Company, who described and demonstrated the technique of using "Faxfilm" for making plastic replicas of metal and other surfaces. Its simplicity and complete reproduction of surface details were most impressive. Specimens of electropolished stainless steel and copper plate brought by those attending were included in the demonstration.

The first item of business was the election of Convention Delegates. DR. W. BLUM, A. PIERDON and F. OGBURN were chosen, with K. M. HUSTON, T. F. SLATTERY and G. E. BEST as alternates.

Much discussion ensued regarding current moves in the direction of raising the minimum dues and increasing the per capita tax. A definite decision was left pending the receipt of information from the Executive Board establishing the need for increased revenue, and indicating the extent to which the per capita tax should be raised to meet the need. Anticipating an increase within the foreseeable future, however, and recognizing that income to the Branch must be increased to take care of operating expenses, the Branch voted unanimously to increase the dues from $9 to $12 effective April 1, 1951, continuing the stipulation that $1 from each member's dues be presented to the Research Fund.

After Ken Huston had installed the new officers and charged them with their duties, the meeting adjourned to informal discussion and refreshments.

GEORGE E. BEST,
Secretary

BRIDGEPORT BRANCH

Thirty-nine members attended the meeting on March 9. WILLIAM EHRENCRONA was thanked for his excellent management of the recent Old Timers Night. MR. MASKOWSKI, father of member HENRY MASKOWSKI, had passed away, and the Branch had sent a floral offering as an expression of its sympathy with the family. A fruit basket was sent to member BILL THOMPSON, who was ill.

Three membership applications were received, and five members were suspended for nonpayment of dues.

LIBRARIAN R. C. BARRETT introduced MR. HENRY MAHLSTEDT, of United Chromium, Inc., who discussed the "Unichrome Self-Regulating High-Speed Chromium Plating Baths" (see 1950 *Proceedings*).

Refreshments were served after the meeting.

JOSEPH G. STERLING,
Secretary-Treasurer

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Branch News

CINCINNATI BRANCH

Despite the arrival of the belated, but much welcomed spring zephyrs, the Branch had an excellent turnout at its meeting on April 25. As usual, it was preceded by an excellent meal.

The meeting was called to order by the newly elected President, ROBERT D. MILLER, who gave notice that he has thorough acquaintanceship with Roberts' Rules of Order. After letters had been read from the Buffalo and Newark Branches in reference to the raising of the membership fees as proposed by the Boston Branch, a discussion was held. It was the feeling that an audit of the Society should be made available to the members, and the Delegates were instructed to request that an audit be sent to all Branches for their information. A committee was then appointed to make appropriate recommendations.

RAY BARRY and STEWART CHIPMAN were appointed a Picnic Committee to determine the right date and place for this summer's function.

MR. RICHARD W. COOK, of the Brush Development Company, Cleveland, was introduced as the evening's speaker. The developer of "The Faxfilm Method for Comparing Surface Roughness", Mr. Cook explained his process of examining surfaces on all types of metal, wood, plastics, etc. By the use of slides he was able to show defects in various surfaces. A short question-and-answer period followed his highly illuminating talk.

The members then enjoyed a Social Hour as the guests of MacDermid, Inc., Waterbury, Conn.

CHARLES WISE, *Secretary*

DALLAS–FORT WORTH BRANCH

This new Branch held its March meeting on the 9th in the Melrose Hotel, Dallas, Texas. Dinner was served at 7:00 P. M. with 50 present. The meeting was then called to order for the purpose of electing permanent officers.

MR. ARTHUR W. LOGOZZO, President of the Nutmeg Chrome Corporation, Hartford, Conn., and A. E. S. Past President, who was our guest speaker, acted as moderator.

The following were elected:

President—FRANK E. LANE
First Vice-President—C. P. LAVELLE
Second Vice-President—J. H. O'NEAL
Secretary-Treasurer—C. A. WHITE
Librarian—R. H. HIPPEL
Board of Managers—J. H. MCNEFF, A. R. LARSON, R. H. THOMAS, M. A. ZETO

After the business meeting, Mr. Logozzo showed a very interesting film and slides on decorative and hard chromium, followed by discussion of chromium plating.

C. A. WHITE,
Secretary-Treasurer

DAYTON BRANCH

The regular meeting for April was a Smorgasbord Dinner meeting held at the Red Gables. After a short business session the Librarian introduced the speaker of the evening, MR. P. R. LYONS, Manager of Electrical Sales, Hanson-Van Winkle-Munning Company. His subject, "Plating Room Electrical Equipment", was well covered, and his talk was followed by a lively question-and-answer period.

Those present then settled down into small groups, further discussing the subject at hand while enjoying snacks and refreshments. The 34 members and friends attending would agree that they had an interesting as well as a good time.

R. M. CLINEHENS, *Secretary*

HARTFORD BRANCH

Close to 45 members and guests attended the regular monthly meeting in Hotel Bond on April 16. Preceding the meeting, a movie, "Metal Magic", was shown through the courtesy of the General Electric Company.

The speaker of the evening was MR. ROBERTS J. PECK of the Electric Products Company. Dealing with "Generators and Rectifiers", he outlined briefly their history and illustrated modern developments by means of slides. The rectifier was first introduced in quantity to the plating industry during the last war. By far cooling, a lesser number of plates could be used for a given output. The importance of using clean air for fan cooling was emphasized, and it was shown how the location and atmospheric conditions can cause a rectifier to burn out. The copper oxide, copper sulfide and selenium types were discussed. Advantages of rectifiers are: lower first cost; the output can be increased by adding more units; high efficiency over a wide range of output, and lighter weight. Advantages of generators are: reliability, higher efficiency at maximum output, longer life, and better voltage regulation.

WILLIAM CULLEN was the technical chairman for the evening, and refreshments were served through the courtesy of MacDermid, Inc.

STANLEY PLATOZ, *Secretary*

INDIANAPOLIS BRANCH

The Branch made its annual trip to Columbus, Ind., on April 4, for the steak dinner served at Arvin Industries Cafeteria. More than 80 members, wives, and guests were present.

Short business meeting was held with PRESIDENT C. C. WEEKLY presiding. Later he was presented his past president pin and spoke a few words in appreciation of the cooperation extended to him during the past year.

Report of committees dealt with the Annual Educational Session, Dinner, Entertainment and Dance to be held at Indianapolis Athletic Club on April 28.

Election of officers was the evening's special business. The following were elected for the ensuing year:

President—A. KRIESE
First Vice-President—C. C. WEEKLY
Second Vice-President—H. PHILLIPS
Treasurer—ROBERT BRUCK
Secretary—EDWARD BRUCK
Librarian—E. LUNDBERG
Board of Managers—MISS EDA ROHRABAUGH, THOMAS EVANS, Q. SHOCKLEY

A trip through Cummins Diesel Engine Company, arranged by TOM EVANS, showed how diesel engines are manufactured.

EDWARD BRUCK, *Secretary*

LANCASTER BRANCH

The April meeting was held on the 13th, at the home of CHARLES SNYDER in Harrisburg, Pa. Approximately 50 members and guests attended.

The following officers were elected for the next fiscal year:

President—EDWARD BEMILLER, Hanover, Pa.
Vice-President—WILLIAM FORDNEY, Lancaster, Pa.
Secretary-Treasurer—HARRY SAYLOR, Elizabethtown, Pa.
Librarian—MRS. MARIAN MEYERS, Mt. Wolfe, Pa.
Board of Managers—LESTER WAGNER, York, Pa.; J. KURTZ BRUBAKER, Lancaster, Pa.; LEROY HAIN, Lancaster, Pa.

LIBRARIAN RAY VINES introduced the speakers of the evening, MR. ROLAND HOENSTINE, Superintendent of the American Wire Fabrics Company, Mt. Wolfe, Pa., and MR. HARRY HOVIS, Supervisor of Chemical Research, Hamilton Watch Company, Lancaster, Pa., who presented a demonstration on "What Happens in a Plating Bath". The demonstration was performed by placing a small glass tank with plating solution in a projector and projecting the plating action on a screen. The baths used were copper cyanide, cadmium, nickel, silver, conventional chromium, and SRHS chromium. The change brought about by wetting agents and other bath additions could be seen, as could the effect of periodic-reverse plating. Considerable discussion followed, of problems that this demonstration brought to light.

HARRY SAYLOR,
Secretary-Treasurer

LOS ANGELES BRANCH

At our April 11 meeting, we had the good fortune to be addressed by one of our local members, MR. GILBERT EXTALE, Chief Chemist of the General Electric Company Plant, Ontario, Calif. Mr. Extale's paper and slides gave us the complete story on the production of cast-iron sole plates for electric irons: from pig iron and scrap into the foundry, methods of pouring and trimming, and fully automatic polishing, through the automatic

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The UNIQUE PRINCIPLE which makes No-Cro-Mist so effective is the change it makes in the physical characteristics of the plating bath. Instead of the usual sizes of gas bubbles liberated, which may be up to .016 inch in diameter, with No-Cro-Mist they are reduced in size to only about one-fourth this diameter, or .004 inch. As an example, if a container of oil or honey is turned upside down and shaken, the large air bubbles rise rapidly, while the small air bubbles scarcely move. The same thing happens in chrome plating baths with No-Cro-Mist, so that when bubbles are small, they rise so slowly and strike the surface with so little energy that hardly any spray comes from the surface of the tank—in fact the amount of chrome spray is reduced up to 95% of normal.

FOR CHROME OVER COPPER, ZINC, OR NICKEL, No-Cro-Mist eliminates chrome spray etch while work is lowered into the tank. No-Cro-Mist also saves expensive maintenance and repairs, keeps workers satisfied. It even lets grass grow outside the plant and saves the paint on parked automobiles by keeping the spray inside the tank where it belongs.

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Operating Temperature .....°F.
Chromic Acid Content .....

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nickel plating, nickel buffing, and automatic chromium plating. Mr. Extale showed samples of the iron in various states of manufacture, which indicated very clearly why the operations were carried out. Discussion of several features of the paper followed the presentation.

Mr. H. J. Struckhoff, of Lasalco, Incorporated, St. Louis, Mo., gave a brief description of the functions of the Finance Subcommittee of the A. E. S. Research Committee and urged the Branch to back the Research Program with time, effort and money.

The slate of officers elected at our March meeting was installed by Earl Coffin. Don Bedwell, Chairman of the Committee for the 21st Annual Educational Session and Dinner Dance, reported that plans were completed.

G. Stuart Krentel, *Secretary*

NEWARK BRANCH

The regular meeting on March 16 was opened by Howard Cobb, who showed an interesting color film of the Colorado Rockies which he had taken from the air.

During the business session, one new member was elected and one in-transfer accepted. No action was taken on the Boston resolution for increasing the per capita tax, but a resolution was passed requesting an open accounting of the revenues from and expenditures for Plating during past years.

Dr. Linford read the Nominating Committee's report, which was accepted without changes. The following were elected to hold office from April 1, 1951 to March 31, 1952, and installed by Sam Taylor:

President—Frank England
First Vice-President—John Gumm
Secretary-Treasurer—George Wagner
Recording Secretary—Samuel S. Frey
Librarian—Robert Horrocks
Sergeant-at-Arms—Thomas Austin
Board of Managers—Horace Smith (honorary), John DeVries, Myron B. Diggin, Edwin Bowerman

Mr. H. E. Boyer, American Bosch Corporation, spoke about "Characteristics of the Basis Metal in Relation to Electroplating". His excellent presentation was confined to ferrous metals and illustrated with slides of photomicrographs.

Samuel S. Frey, *Recording Secretary*

NEW YORK BRANCH

The Branch held two meetings during the month of April: on April 13 and 27, respectively. The first, to a large extent, was devoted to a discussion of instructions for Delegates to the Buffalo Convention. The general discussion at this time gives the members a chance to consider carefully how to vote at the actual instruction. A film on the chemical effects of electricity followed the business meeting.

The second meeting was devoted to a lecture by Mr. Vernon C. Burr, of United Chromium, Inc., who gave a very informative and interesting presentation of "Substitute Coatings for Metal". Mr. Burr's talk included information about the latest restrictions on the use of metallic coatings of nickel, copper, zinc, cadmium, and chromium.

Peter L. Veit, *Recording Secretary*

PHILADELPHIA BRANCH

About 40 members and guests heard Mr. Gerald A. Lux, Oakite Products, Inc., give an excellent presentation of "The Fundamentals of Alkaline Cleaning" on March 30. Why cleaners clean is not known; there is no one yardstick for evaluation of cleaners or cleaning. The factors involved in compounding of a simple soak cleaner were demonstrated in an extremely effective manner: (1) Saponification, the action of caustic soda on vegetable or animal oils (not mineral oil) to produce water-soluble soaps. (2) Emulsification, obtained by mixing soap with mineral oil. A temporary emulsion is desired to prevent entire cleaner from changing to a solid permanent emulsion. (3) The effect of hard water on soap. No suds were obtained until an excess of calcium salts had been added to solution. Soda ash removes hardness by precipitating calcium salts as calcium carbonate, which, however, is not free-rinsing. Phosphates cause a floculant and free-running precipitate to form. Soap mixed with water softener (soda ash or phosphates) will react with calcium precipitates and cause other objectionable precipitates, but polyphosphates sequester calcium eliminating the precipitate when soap is added and dissolves an existing precipitate. No synthetic detergent has the properties of soap. (4) Every soap or detergent has a *p*H range where it exhibits maximum detergency. To hold a soak cleaner in this range necessitates the use of a buffering agent. (5) To suspend smuts and put them into a free rinsing state, a mineral colloid, such as a silicate, is necessary.

The following general information was given: Every 20° F rise above 140° of the temperature of a soak cleaner reduces the cleaning time by 50 per cent. A freshly made nonferrous-metal cleaner should be boiled for at least 40 minutes before use to remove the dissolved oxygen that may cause brass to tarnish; large quantities of fresh cold water should not be added, only a trickle to maintain loss by evaporation. Less than 1 ppm of chromic acid in a cleaner can cause passivation of the basis metal in subsequent plating operations.

The Boston Branch dues-increase amendment was tabled until the Society budget is received. The draft of the Branch By-Laws, as prepared by the Committee and read by Committee Chairman Fulforth, was approved with several changes.

The following were elected to office for the 1951–1952 term:

President—Alfred H. Pope
First Vice-President—Edwin F. Ottens
Second Vice-President—William H. Trusdell
Secretary—I. William Marcovitch
Treasurer—George M. Long
Librarian—Clarence E. Boerckel
Board of Managers—Paul Mentzer, Sr., Samuel Heiman, Robert L. Farren, Jr., Nat. Verrelle
Delegates—Samuel Heiman, I. William Marcovitch, George M. Long
Alternates—Frederick Fulforth, Nat. Verrelle, Delmar R. Robson

The newly elected officers were installed by A. E. S. Past President Fulforth. Four new active members were admitted; four applications for active membership were referred to the Board of Managers.

I. Wm Marcovitch, *Secretary*

ROCHESTER BRANCH

The large turnout at the April meeting, particularly from the Rochester Products Division of General Motors, was a tribute in part to our speaker, Mr. Bert G. Daw, President of Lasalco, Inc., and in part to the efforts of Librarian John Adams of Rochester Products.

The business meeting was short, being principally concerned with the report of the Nominating Committee and of the Annual Meeting Committee. Plans for the latter sounded especially interesting, including, as they did, an evening at the Rochester Red Wings Stadium.

Mr. Daw's talk, entitled "What Happens in a Plating Barrel", proved entertaining as well as interesting. After winning his audience with a humorous "morale building" letter to a G. I. in Korea, the speaker stressed the economy of barrel plating and the necessity for not overloading the barrel. The latter point was vividly portrayed in an excellent movie showing the action in a plating barrel as seen through a window. For dessert, the speaker exhibited some excellent colored movies taken at the Grand Canyon and vicinity.

Walter F. Swanton, *Secretary*

ROCKFORD BRANCH

The March meeting was held at the Faust Hotel with 42 on hand for the dinner and 61 for the technical session.

Committee reports indicated that arrangements were complete for the Annual meeting on March 31. The final report of the committee studying our By-Laws was read, and the changes recommended were accepted.

Bill Geissman introduced the speaker, Mr. Orville Kocour, of the Kocour Company, Chicago, who spoke on "Thickness Testing Equipment and Methods". After discussing common practices, Mr. Kocour presented the new "Electronic Thickness Tester". He introduced Mr. Hodges of his organization, who explained

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this equipment in detail and then ran actual tests on sample parts. An interesting discussion period closed themeeting.

VERN WISSEN, *Secretary*

ST. JOSEPH VALLEY BRANCH

At the regular monthly meeting in Hotel Elkhart, Elkhart, Ind., on April 4, 33 members and guests were present for the dinner, and 46 attended the technical session.

One application for membership was presented; one resignation and one intransfer were accepted.

JOHN LOCKERBIE recommended that a parting gift be given to retiring president in appreciation. JOHN BAYMAN, Chairman of the annual Ladies Night on May 2, announced the program for that night.

By unanimous vote the following were elected to office for 1951–1952:

President—DR. ERNEST J. WILHELM
First-Vice-President—RICHARD C. LOCKERBIE
Second Vice-President—WILLIAM S. MCDOWELL
Librarian—JOHN C. BAYMAN
Secretary-Treasurer—EUGENE ROTH
Board of Managers—DAVID A. LE FEVRE (one year), ELMER O. BRADY (2 years), CHARLES R. SIGLER (three years)

Dr. Wilhelm introduced the speaker, MR. C. F. NIXON, A. E. S. First Vicedent and Director of Process Engineering of the Ternstedt Division, General Motors Corporation. Mr. Nixon introduced his guest, MR. HERBERTH HEAD, of Briggs Manufacturing Company, Vice-President of the Detroit Branch.

The topic of the evening was "Polishing and Buffing". With a series of slides, Mr. Nixon showed various types of polishing and buffing machines, from the hand-operated lathe to automatic machines. He also introduced pictures of a new production finishing machine, in which the work is forced through an abrasive slurry. It offers savings in both supply and labor costs.

In considering a polishing and buffing problem, one must weigh the following factors: type of work, type of wheel, type of fabric in the buff. In many applications, lower wheel speeds will give a better finish and save polishing supplies. The utilization of used buffs was also touched upon. After the regular talk, Mr. Nixon participated in an open discussion of problems raised by NPA orders, and Mr. Head gave us the benefit of his experiences along these lines. Substitute finishes were also discussed.

The Branch is indebted to Mr. Nixon for coming on only a few days' notice.

EUGENE ROTH,
Secretary-Treasurer

SPRINGFIELD BRANCH

Twenty-four members and guests were present at the April meeting at the Hotel Charles.

The newly elected officers were installed, and two new members were elected. E. DUPUIS gave a brief resume of the Boston Annual Convention.

The speaker, MR. F. L. ROXBROUGH, was introduced by our new Librarian, R. HEROUX. The subject of Mr. Roxbrough's talk was "Materials Handling". Saving shoe leather by planned layout of equipment; conveyorizing where possible; positive temperature control; and eliminating wastage of water and solutions, all as related to plating, were the salient points of his talk.

Slides were shown, and a brief discussion period was held, before a social hour was enjoyed through the courtesy of the Hampden Color and Chemical Company.

E. F. KOETSCH, JR., *Secretary*

SYDNEY BRANCH

The 70th regular meeting of the Branch was held on March 8. The newly elected president, J. F. MURPHY, delivered his presidential address, which took the form of a discussion of the application of electroplating in the locomotive industry. The talk was well arranged and delivered; Mr. Murphy proved himself a speaker of ability and experience.

A long question session followed, with Mr. Murphy answering the members' questions to the satisfaction of all.

W. W. PATERSON, *Secretary-Treasurer*

SYRACUSE BRANCH

The Branch held its March 19 meeting in the Hotel Syracuse with 20 members attending.

The speaker of the evening was MR. G. B. BOWMAN, Chief Chemist, Standard Steel Spring Company, Coraopolis, Pa. His talk on "The Corronizing Process for Metallic Protection" was illustrated with lantern slides and proved very interesting. The Corronizing process has many advantages in its specialized field of corrosion prevention.

The names of the officers-elect were reported by PAST PRESIDENT HERB GERHARDT as follows:

President—HENRY HOLBERT
First Vice-President—K PARNELL
Second Vice-President—DANIEL GRAY
Librarian—DON MORRIS
Treasurer—WALTER PIASECKI
Secretary—LINDLEY WOOD
Board of Managers—TED DUVALL, HERBERT GERHARDT, NEIL MAFFEI

DAN GRAY, VINCENT MCCONNELL and MAT BOLAND were elected Delegates to the Buffalo Convention, with HENRY HOLBERT, TED DUVALL and E. E. HOLLISTER alternates.

A picture on "Safety" was shown through the courtesy of the Socony-Vacuum Oil Company.

LINDLEY S. WOOD, *Secretary*

(*Continued on page 613*)

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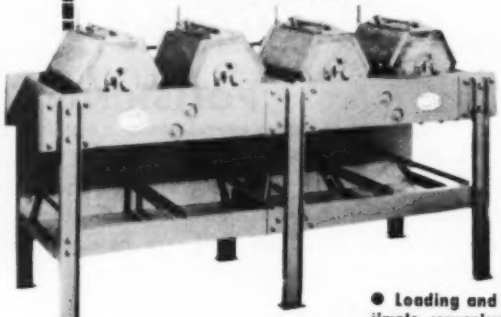

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No. 909 and No. 12 are easily applied to a variety of different cleaning routines. No. 909 is a unique heavy duty soak tank cleaner. No. 12 is an electrocleaner for both direct and reverse current. The following case history is typical of the results you can expect through the application of Diversey No. 909 and No. 12.

TUBULAR STEEL FURNITURE CASE HISTORY

PROBLEM: To clean polished steel tubular furniture prior to bright nickel and chromium electroplating.

FORMER PROCESS: Included mineral spirits soak, handwipe, spray wash, alkaline soak and two electrocleaning operations. Six men, working steadily, were required.

PRESENT PROCESS: Includes Diversey No. 909 soak, and Diversey No. 12 reverse current electroclean.

RESULTS: The Diversey Process completely removes oil and grease from the inside of the tubes, avoiding contamination of pickle and nickel tanks as characterized the previous process. The cleaner tanks now are dumped every two weeks rather than every week as was formerly necessary. The No. 909 and No. 12 are the only materials this leading finishing plant has found that would eliminate the solvent and handwipe operations. The elimination of handwiping labor costs results in an estimated savings of $15,000.00 per year. A definite improvement in smoothness and luster of the electrodeposit resulted with Diversey No. 909.

COMPLETE INFORMATION AVAILABLE

For additional information, including technical bulletins, write or call your Diversey D-Man. He will be pleased to work with you. Write or call today. *The Diversey Corporation, Metal Industries Department, 1820 Roscoe Street, Chicago 13, Illinois. In Canada: The Diversey Corporation (Canada) Ltd., Lakeshore Road, Port Credit, Ontario.*

Diversey

Membership Report of the A. E. S.

Elections

BALTIMORE-WASHINGTON: J. P. Cadden, E. T. Heilman
BRIDGEPORT: R. E. Bonazzo, N. Carpenter, Z. Sivri
BUFFALO: K. R. Humes, D. Kilmurray
CHICAGO: J. Abramson, C. L. Carll, S. A. Cooperman, C. J. Crescio, D. W. Dunning, E. F. Gestar, F. O. Harris, F. H. Lanz, L. P. Lanz, A. Lazaro, C. S. Machalski, F. H. Meller, D. D. Pioli, W. Shaw, C. Sittner
DALLAS-FORT WORTH: *V. L. Baltzell, *G. E. DeVaney, *R. E. Doring, G. W. Fitzhugh, A. C. Fricke, *C. Hamrick, *B. L. Huffer, *R. W. Johnston, *R. G. Johnston, *O. H. Kernodle, *C. E. Lane, *J. R. Lane, *C. P. Lavelle, *J. H. McNeff, G. J. Mellina, Jr., *R. E. Miller, J. H. O'Neal, *J. J. Phillips, *R. V. Redus, *J. T. Shaw, *A. Strangi, *E. C. Teer, *W. M. Teer, Sr., *W. M. Teer, Jr., *W. H. Vaughan, *J. D. Webb, *C. A. White, *W. S. White, M. A. Zito
DETROIT: L. O. Case, W. A. Donakowski, J. R. Newby, R. G. Spain, C. P. Wolski
HARTFORD: H. J. Bertrand, M. K. Cassells, F. Garavelli
INDIANAPOLIS: *C. A. Barker, *J. F. Peacock
LANCASTER: W. H. Yarnall
LOS ANGELES: H. C. Jennings, Jr., V. E. Sciamanna
MELBOURNE: B. Pearce
MILWAUKEE: N. J. Farmer, W. H. Heinen, E. H. Meiers, J. F. Meyer, F. Zeigler
NEW YORK: E. C. Baker
PHILADELPHIA: *F. C. Lawlor, *T. R. Metz, *W. J. Osbourne, *F. Perazza
ROCHESTER: *L. Treman
ST. JOSEPH VALLEY: O. G. Close
SOUTHEASTERN: E. R. Hines, J. A. Jones
SPRINGFIELD: R. P. Crowley, R. J. Girard
SYRACUSE: E. Maffei, J. Maffei
MEMBERSHIP-AT-LARGE: *F. D. Tubbs, P. L. Schalkwyk

Reinstatements

NEW YORK: *K. K. Miltner
ROCHESTER: *J. Elster
SYRACUSE: E. P. Swartz
MEMBERSHIP-AT-LARGE: *H. Taylor

Transfers

*Robert M. Worrell from Indianapolis to Dallas-Fort Worth
L. G. Hakes from Chicago
J. R. Byerley from Chicago to Houston
F. A. Rudman from Chicago to Houston
R. Brouwer from Grand Rapids to St. Joseph Valley
Chester Borlet to Los Angeles

Membership Competition

BRANCH	Membership Apr. 1, 1950*	New Members*	Net Change in Membership*	Per Cent Net Change*
First Group				
Milwaukee	143	5	+ 5	+ 3.5
Chicago	409	15	+13½	+ 3.3
Bridgeport	152	3	+ 2	+ 1.3
Los Angeles	211	2	+ 2	+ 0.9
Hartford	137	3	+ 1	+ 0.7
Detroit	492	5	+ 3	+ 0.6
New York	279	1	+ ½	+ 0.2
Melbourne‡	126	1	...	...
Newark	239	...	...	...
Boston	151	...	...	...
Pittsburgh	132	...	...	...
Grand Rapids†	164	...	− ½	− 0.3
Cleveland	205	...	− 1	− 0.5
Philadelphia	201	...	− 1	− 0.5
Waterbury	126	...	− 1	− 0.8
Second Group				
Buffalo	85	2	+ 2	+ 2.4
Syracuse	85	2	+ 2	+ 2.4
Baltimore-Washington	87	2	+ 2	+ 2.3
St. Joseph Valley	71	1	+ 1	+ 1.4
Toronto	121	...	...	...
New Haven	108	...	...	...
St. Louis	105	...	...	...
Providence-Attleboro	100	...	...	...
Indianapolis	92	...	...	...
Rochester	88	...	...	...
Dayton	82	...	...	...
Montreal	77	...	...	...
Rockford	67	...	...	...
Sydney	93	...	− 2	− 2.2
Cincinnati	88	...	− 2	− 2.3
Third Group				
Dallas-Fort Worth	31	5	+ 5	+16.1
Houston	25	...	+ 1½	+ 6.0
Southeastern	48	2	+ 2	+ 4.2
Springfield	54	2	+ 2	+ 3.7
Lancaster	60	1	...	...
Twin City	66	...	...	...
Adelaide	65	...	...	...
San Francisco	65	...	...	...
Saginaw Valley	57	...	...	...
Columbus	54	...	...	...
Jackson-Lansing	52	...	...	...
Allentown-Reading♦	42	...	...	...
Hamilton	25	...	...	...
Louisville	23	...	...	...
Western Ontario	23	...	...	...
Toledo	45	...	− 1	− 2.2
Outside Competition				
At Large	120	1	+ 1	...
In Transfer	16	...	+ 2	...
Total A. E. S.	5,387	53	+39	+ 0.7
Active Membership, May 1, 1951			5,426	

*Subject to correction. †, ‡, ♦ Winners in first, second and third group, respectively, of 1950–1951 membership competition.

Gustav Oetterman from Los Angeles to Houston
D. B. Lytle from New York
C. H. Castle from St. Joseph Valley

Resignations

BRIDGEPORT: E. Wilson
CINCINNATI: J. B. Stace
CLEVELAND: R. Garver
DETROIT: R. V. Anderson, E. Snyder
HARTFORD: R. J. Seneff, W. Yeamans
LANCASTER: K. K. Nuss
MELBOURNE: C. S. Smart
PHILADELPHIA: C. D. Briddell
SYDNEY: W. J. Brown, A. P. Hinton
ST. JOSEPH VALLEY: *C. Hambidge
SYRACUSE: F. R. Morral
TOLEDO: R. Guider
TORONTO: *R. G. Haacke, *W. Moore, *C. T. Stein

Suspensions

BUFFALO: *F. E. Buseman
CINCINNATI: J. Blinkhorn
INDIANAPOLIS: *C. L. Slavey
NEW YORK: *R. E. Allison, *W. R. Bayer, *O. Brill, *R. Buttacavoli, *H. S. Buttenheim, *R. Carnevale, *J. P. Cordone, *L. Edwards, *W. N. Elman, *S. Halpern, *J. Isaacs, *B. Lapidus, *W. J. Manson, *W. K. McCown, *A. Medina, *H. J. Mosier, *C. J. Peterson, *D. Price, *B. Romeo, *E. Moll, *H. Suss, *C. K. Turner, *J. P. Ulrich
PHILADELPHIA: *F. C. Price, *I. F. Snow, *E. Wiseburn
ROCHESTER: *M. A. Furfaro, *D. M. Grob, *J. R. McGuire, *R. G. Puder
TORONTO: *J. Biden, *C. Colwill, *R. Graham
WATERBURY: J. S. Holley
*During calendar year 1950–1951

Branch News

(*Continued from page 610*)

TORONTO BRANCH

The regular monthly meeting was held February 9 in the Royal York Hotel.

Mr. K. P. Bellinger, of The Chemical Corporation, Springfield, Mass., was the guest speaker. His talk about "Zinc Plating and Passivating Dips" was enjoyed by all. It was very timely, with nickel in such short supply and so many platers looking for a substitute.

Nominations for the executive of the 1951–1952 year were made, but the balloting will be by mail so as to reach all Branch members.

Mr. Benny Cameron gave a report on the Annual Dance at the Club Kingsway in December. More than 500 were present. Hats off to him for producing our most successful dance yet, and with a profit of about $300. Cy Short reported on the progress of the Research Finance Committee. Whereas a fair portion of the necessary monies has been received from new sustaining members, it is still short of the mark required to go ahead with the project.

A. L. Coxhead, *Correspondent*

SPARKLER FILTERS · SPARKLER FILTERS

FREE DRAINAGE IN SPARKLER FILTERS

Cross-section of individual plate, showing perforated metal screen, filter media, and filter cake.

High flow rates cannot be assured by large filtering surfaces *alone*. Another important factor is provision for drain-off space capable of carrying away all liquid that the surfaces can handle.

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53 Galen Street, Watertown 72, Mass.

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79 Chapel Street, Hartford 3, Conn.

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P. O. Box 168, Jenkintown, Pa.

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Chairman.....Dr. W. A. WESLEY
The International Nickel Co., Inc., Bayonne, N. J.

Secretary.....The Executive Secretary

LOCAL BRANCHES (Changes Only)

ALLENTOWN-READING meets third Wednesday of each month in Spurgeon's Hotel, Allentown, Pa. Secretary-Treasurer, Mrs. Pearl T. Treisbach, 610 Allen Street, Allentown, Pa. Research Finance Committee Chairman, William R. Pfeiffer, Jr., 975 Green Street, Allentown, Pa.

BUFFALO meets first Friday of each month in Markeen Hotel. Secretary and Research Finance Committee Chairman, B. P. Fortin Jr., 209 Forest Drive, Orchard Park, N. Y.

DALLAS-FORT WORTH. Secretary, C. A. White, 4036 Commerce Street, Dallas 1, Texas.

DAYTON meets first Friday of each month in Engineers Club. Secretary, Paul E. Geske, 41 S. Bromfield Road, Dayton 9, Ohio. Research Finance Committee Chairman, Robert L. Ruleff, 1002 Broadview Boulevard, Dayton 9, Ohio.

HOUSTON meets fourth Friday of each month at 7:30 P. M. Secretary-Treasurer, J. R. Byerley, Dixie Electroplating Company, 3001 Engelke Street, Houston, Texas.

INDIANAPOLIS meets first Wednesday of each month at Fox Steak House, 1207 Washington Street. Secretary, Edward Bruck, 824 Graham Avenue, Indianapolis 1, Ind.

JACKSON-LANSING meets second Tuesday of each month alternating between Hayes Hotel in Jackson and Porter Hotel in Lansing. Secretary-Treasurer, Fred Stuckenberg, P. O. Box 501, Lansing 2, Mich.

SOUTHEASTERN meets second Friday of each month in Robert Fulton Hotel, Atlanta, Ga. Secretary-Treasurer and Research Finance Committee Chairman, Dr. Fred W. Cox, Engineering Experiment Station, Georgia School of Technology, Atlanta, Ga.

WHAT'S THE BEST WAY TO STRIP PAINT FROM METAL PARTS TOO LARGE TO BE SOAKED IN TANKS?

See Page 3

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answers many questions that will lead you to better stripping procedures. You'll want to read more about:

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What is the best method when steam is not available? *See page 7.*

What is the cheapest way to strip metal parts in large volume? *See page 9.*

What are the best ways to prepare stripped surfaces for repainting? *See page 11.*

What strippers are best for removing oil-base paints? . . . Synthetic enamels, alkali-resistant plastics or resin-based paints? . . . Japans, wrinkle finishes, nitrocellulose lacquers, alkyds, phenolics and ureas? *See page 12.*

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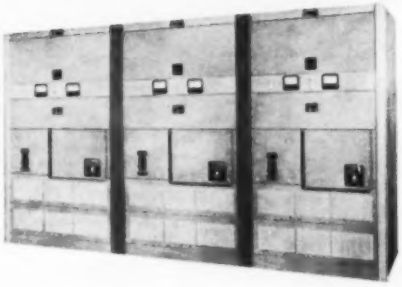

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AMERICAN ELECTROPLATERS' SOCIETY Annual Convention in Hotel Statler, Buffalo, N. Y., on July 30-August 2.

AMERICAN CHEMICAL SOCIETY Diamond Jubilee Meeting in New York City on September 3–7.

6TH ANNUAL INSTRUMENT CONFERENCE AND EXHIBIT, sponsored by the Instrument Society of America, in Sam Houston Coliseum, Houston, Texas, on September 10–14.

THE ELECTROCHEMICAL SOCIETY Fall Conference in Statler Hotel, Detroit, Mich., on October 10–13.

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